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STUDY OF FACTORS THAT INFLUENCE THE
USE OF RESPIRATORS IN URANIUM MINES

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A report prepared by F. Kalos, Atomic Energy of Canada Limited, under contract to the Atomic Energy Control Board (CRNL-2973).

ABSTRACT

A statistical analysis was performed of the responses to a user's survey by uranium miners who were voluntary users of a helmet-type powered respirator. The analysis concludes that the duration of visor-lifting was lognormally distributed with a geometric mean of 1.15 hours. Use depends strongly on job category. Many of the factors examined by the survey were use-dependent instead of use-determining, or had no effect on proper use. Many of the miners stated the respirator could not cope with hard work, its visor fogged up. The very abundance of these comments prevented confirming an association between fogging and use by statistical means. Recommendations on future user's surveys are given.

RÉSUMÉ

On a effectué une analyse statistique des réponses fournies, lors d'une enquête, par des mineurs d'uranium, utilisateurs volontaires d'un respirateur mécanique de type "casque". L'analyse a conclu que le temps où la visière restait levée, suivait une distribution lognormale avec une moyenne géométrique de 1,15 heures. L'utilisation dépend fortement du type de travail. Plusieurs des facteurs examinés lors de l'enquête se sont révélés dépendants de l'utilisation plutôt que déterminants de celle-ci, ou bien n'avaient simplement aucun effet sur l'utilisation correcte de l'appareil. Beaucoup de mineurs ont fait état de l'insuffisance de l'appareil lors d'un travail intense, menant à une condensation sur la visière. L'abondance même de ces remarques a empêché d'établir une association entre la condensation et l'utilisation. Des recommandations sont présentées pour de futures enquêtes.

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TABLE OF CONTENTS

ABSTRACT.....	i
LIST OF TABLES.....	v
LIST OF FIGURES.....	vi
ACKNOWLEDGEMENTS.....	vii
A. GENERAL REPORT.....	1
1. Introduction.....	1
1.1 Background and Objectives.....	1
1.2 The 1984 Users Survey.....	2
1.3 The Organization of the Report.....	2
2. Analysis and Results.....	2
2.1 Answers to Survey Questions.....	2
2.2 Users' Comments.....	5
2.2.1 General	
2.2.2 Comments Related to Proper Use	
2.2.3 Comments Related to Acceptance	
3. Conclusions.....	6
4. Recommendations.....	8
B. STATISTICAL ANALYSIS.....	10
1. Statistical Methods.....	10
1.1 General.....	10
1.2 Levels of Measurements.....	10
1.3 Selection of Tests.....	10
1.4 Measures of Association and Significance Levels.....	12
1.5 Limitations.....	13
2. Association Between Job and Proper Use.....	13
2.1 General.....	13
2.2 The Coding of Job Classification Responses.....	13

2.3	The effect of Job on Use.....	13
2.4	Further Regrouping into Job Categories (JOBCAT).....	15
2.4.1	STOPE	
2.4.2	EQUIPMT	
2.4.3	SERVICE	
2.4.4	MUCK Handling	
2.4.5	LEACHING	
2.4.6	UNDEFD	
2.5	The Association Between Use and Job Categories.....	17
2.6	User Categories (USECAT) and their Association with Job Categories.....	17
3.	The Effect of Factors Other Than Job on Use.....	17
3.1	General.....	17
3.2	Factors Not Significantly Associated with Use.....	21
3.2.1	EXPER: Length of Experience with AIRSTREAM	
3.2.2	COMFORT: Responses to Question 4	
3.2.3	VISION: The Quality of View through the Visor	
3.2.4	TALK: Lifting the Visor when Talking	
3.2.5	AIRFLOW: Drop in Airflow during the Shift	
3.2.6	SERV: The Quality of Service	
3.3	Factor that Depends on Use: Encountering Equipment Failure...	22
3.4	The Effect of TRAVEL - Travelling with the Visor Down - on Use.....	22
4.	Analysis for Relative and Combined Effects.....	24
4.1	General.....	24
4.2	Controlled Crosstabulations.....	24
4.3	The Distributions of Non-Use.....	24
4.4	Analysis of Variance (ANOVA).....	29
5.	Job Category Profiles.....	31
5.1	General.....	31
5.2	Descriptive Statistics.....	31
5.3	Controlled Crosstabulations.....	31
5.3.1	General	
5.3.2	The Dependence of Use Category on Job Category	
5.3.3	Job-Category - Specific Effects on Use Category	
5.3.4	Other Associations Tested	

5.4	ANOVA of Non-Use within Job Categories.....	35
6.	Analysis of Users' Comments.....	35
6.1	General.....	35
6.2	The Nature of Comments.....	35
6.2.1	The Most Frequent Comments	
6.2.2	Comments Related to Fan Performance	
6.2.3	Comments Related to Task and Position	
6.2.4	General Comments	
6.2.5	Comments Related to Visor and View	
6.2.6	Comments Related to the Respirator	
6.2.7	Comments Not Classified and Tabulated	
6.3	Frequency Tabulations.....	37
6.4	Crosstabulations: Dependence on Use Category.....	42
6.5	Crosstabulations: Job Category Profiles.....	46
6.6	Other Factors Tested.....	50
6.7	Leaching Attendants.....	50
	REFERENCES.....	50
APPENDICES:		
	SAMPLE OF COMPLETED SURVEY FORM	APPENDIX A
	LEACHING ATTENDANTS' RESPONSES	APPENDIX B

LIST OF TABLES

CHAPTER A

Table 1-1: Summary of Fixed Form Responses.....	3
---	---

CHAPTER B

Table 1-1: Glossary of Variable Names.....	11
Table 2-1: The Extent of Use by Different Job Classifications.....	14
Table 2-2: Tests of Homogeneity within Job Categories (JOBCAT).....	16
Table 2-3: The Extent of Use by Different Job Categories.....	18
Table 2-4: Crosstabulation of Use Categories by Job Categories.....	19
Table 3-1: Tests of Association between Use and Other Factors.....	20
Table 3-2: Crosstabulation of Use Category by Travel.....	23
Table 4-1: Controlled Crosstabulations.....	25
Table 4-2: ANOVA of NONUSE by JOBCAT and TRAVEL.....	30
Table 5-1: Descriptive Statistics of Survey Answers by Job Categories.....	32
Table 5-2: Characteristic Times with No Failures.....	33
Table 6-1: Comments re Problems with Comfort.....	38
Table 6-2: Comments re Problems with Visor.....	39
Table 6-3: Comments re Hindrance in Work.....	40
Table 6-4: General Comments.....	41
Table 6-5: Comments, Overall Compilation.....	43
Table 6-6: Frequencies of Comments, After Recoding.....	44
Table 6-7: Crosstabulation of Comments by Use Category.....	45
Table 6-8: Crosstabulation of Detailed Comments by Use Category.....	47
Table 6-9: Crosstabulation of Comments by Job Category.....	49
Table 6-10: Crosstabulation of Detailed Comments by Job Category.....	51

LIST OF FIGURES

CHAPTER A

Figure 1: Relationships between Use Patterns and Other Factors.....	7
---	---

CHAPTER B

Figure 1: Histogram of the Duration of Proper Use Responses.....	26
Figure 2: Cumulative Distribution of Non-Use. Job-Dependence.....	27
Figure 3: Cumulative Distribution of Non-Use. Dependence on Visor - Lifting During Travel.....	28

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STUDY OF FACTORS THAT
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A. GENERAL REPORT

1. Introduction

1.1 Background and Objectives

In 1984, the author collaborated with S.H. Linauskas in a study commissioned by the Atomic Energy Control Board (AECB): "Study of Efficiency and Current Use of Respiratory Protective Devices"(1). This work quantified workplace protection factors and the extent of proper use among the voluntary users of the Airstream AH-5 powered air-purifying respirator helmet* (hereafter: AIRSTREAM) at an Elliot Lake underground uranium mine. The principal recommendation of the study was:

"The most efficient way to improve protection is by increasing proper use with the visor down among the miners".

The 1984 study included a user survey that assessed the extent of proper use, and contained questions related to several factors which appeared related to the extent of proper use. The responses were tallied and described briefly in Section 3 of the report, but a more extensive statistical analysis of them was not within the scope of the 1984 research contract.

"Proper use" of the AIRSTREAM means principally that the visor is in the "down" position. This enables the fan built in the AIRSTREAM to supply the miner with filtered breathing air. From here on, "proper use" will be usually contracted to "use" in this report. Thus lifting the visor and possibly disconnecting the fan from the power-pack constitute "non-use" in the present context, even though the AIRSTREAM remains on the head for use as hard hat and lamp holder.

The miners themselves, their trade union, the mining company and the Atomic Energy Control Board all strive to improve the protection of uranium miners from radon/thoron daughters and dust inhalation. The objective of the present study is to contribute to the above endeavor by examining the causes of use and non-use of the AIRSTREAM protection among the AIRSTREAM users/wearers.

The study analyzes, principally by statistical means, the 1984 users' survey; the scope of inquiry is confined to this single task. It examines the associations among the factors explicitly considered in the survey questionnaire and also among the factors that became introduced by the miner's responses. Examples of factors that are considered are: job description, experience with AIRSTREAM, finds AIRSTREAM "comfortable", "too heavy", "interferes with hard work", "can not bend down".

* The standard AH-5 respirator was adapted to be powered by a miner's cap lamp battery.

A more complete statement of the objectives (and tasks performed) would be as follows:

- i. identify associations between use and user groups;
- ii. identify associations between use and other factors;
- iii. establish profiles of user groups with regard to factors that influence AIRSTREAM use;
- iv. make recommendations regarding follow-up users' surveys that would bring about a better understanding of the causes of use or non-use;
- v. make recommendations on actions that appear to have a potential for improving the extent of use.

1.2 The 1984 Users Survey

The survey and the descriptive statistics of the responses have been presented (1), but some of the information will be repeated or condensed here in order to enable the reading of this report on its own.

Survey questionnaires (Appendix A) were distributed to about 250 AIRSTREAM users and 207 completed questionnaires were collected. Appendix A, which is a completed form picked at random, illustrates that the responses were, technically, of two kinds: "fixed form" ones - such as circling or specifying a number; and "free-form" ones - which were "write-in's" or comments. The fixed-form answers were readily coded and analysed by computer and Table 1-1 presents a summary of these responses.* The most important question of the survey was No. 11 on the extent of proper use. The survey indicated that median use was 6 hours per workshift.

1.3 The Organization of the Report

PART A of the Report (GENERAL REPORT) will describe briefly the analysis done, the findings and the recommendations. The statistical information and analysis that support the statements made in PART A are presented separately as PART B of the Report (STATISTICAL ANALYSIS). This part contains, as well, a more detailed account of the analysis than PART A.

2. Analysis and Results

2.1 Answers to Survey Questions

Proper use of the AIRSTREAM respirator was found to depend strongly on job classification. Miners working in the stopes ranked first in use. The extent of use was about average for the principal user group, consisting of miners who ride on equipment (scoop, truck and heavy equipment operators). Less than average use was reported by tradesmen, labourers and service vehicle operators. The job classifications associated with the highest proportion of "casual" users were: conveyor operator and rockbreaker operator.

* All respondents were regular AIRSTREAM users.

Table 1-1: Summary of Fixed Form Responses

QUESTIONS	ANSWERS		
	Lower Quartile	Median	Upper Quartile
3. How long have you been using the AIRSTREAM?	18 months	2 years	4 years
4. Do you find the AIRSTREAM comfortable to wear?	most of the time	most of the time	always
5. How do you rate the visibility of the AIRSTREAM?	usually good	good	good
6. How often do you find you must lift the visor when talking?	always	most of the time	most of the time
8. Has your AIRSTREAM ever failed in use?	No - 44%	Yes - 56%	
9. During a shift do you ever notice a change in the airflow of the AIRSTREAM?	sometimes	sometimes	never
10. When travelling to and from the cage and your workplace/lunchroom do you wear your visor up or down?	Up - 47%	Down - 53%	
11. When in your workplace how much of the time do you have the visor down?	5 hours	6 hours	7 hours

The only factor besides job classification that appeared to influence the extent of use was the mode of travel to the workplace: as expected, people who travel with the visor up reported less hours of proper use. The choice of the mode of travel (with visor up or down) was not really an underlying cause for the use pattern, but rather a part of it. Furthermore it was found that the mode of travel had no impact on use in the more "casual" user groups: service/trades/labour; conveyor/rockbreaker.

Answers to several of the survey questions showed no association at all with proper use. These non-associated factors were the following:

Experience - There was no association between the length of experience as AIRSTREAM user and the extent of use. However, there was an indication that new users wear the respirator to an extent that corresponds about to the average for the user population, regardless of their job classification. The job-specific use patterns, described in the beginning of this section, prevailed only among users who had worn the AIRSTREAM for two or more years.

The rating of comfort was not related to use. One may explain this by the selection inherent in the voluntary nature of the respirator program: the ones who were not comfortable with the AIRSTREAM have probably dropped out and were not among the population surveyed.

Lifting the visor for talking: The majority of the responses indicated that the visor must usually be lifted for communicating. The survey question was not formulated suitably for measuring the impact of this requirement on proper use.

The quality of service: user satisfaction with repairs and maintenance had no effect on use.

There were two other factors associated with use, but the sense or direction of the relationships indicated they were use-dependent instead of use-determining.

Encountering equipment failure was strongly associated with use: it was reported by a larger proportion of good users than of casual ones. This finding indicated there was some additional form of improper use besides the lifting of the visor, because no reasonable process by which visor-lifting can influence failure frequencies could be conceived. This reasoning led to the conclusion that disconnection of the AIRSTREAM from the power-pack was practiced and constituted an important form of non-use.

A similar association, although weaker, was found between the answers that reported drop in airflow during the shift and the extent of use. Again, this corroborates the conclusion regarding disconnection.

The associations described in the preceding two paragraphs corroborate the honesty of the reported use data and of the drop-in-airflow observations.

The use data collected showed a high degree of regularity: it corresponded to non-use being lognormally distributed - as well for the whole population as for the different job categories. From this regular distribution, which is characterized by a geometric mean of 1.15 hours non-use, one could deduce that even

the miners who reported full-time (7.5 hours) use are likely to lift the visor for about 20 min/shift on the average. Information could also be extracted regarding travel times: they amount to a half an hour per shift, on the average.

Answers to the failure-related question showed that the AIRSTREAM is most failure-prone when used by the trades/service/labour job classifications, with stope jobs ranking next.

2.2 Users' Comments

2.2.1 General

It appears useful to establish here a distinction between factors that are use-determining and factors that are acceptance-determining, because many of the comments received were related to acceptance and not to proper use. Proper use has already been defined in the introduction, but acceptance needs to be explained. In the present context, acceptance means willingness to wear the AIRSTREAM and to participate in the voluntary respirator program.

Acceptance-related factors may have no bearing whatsoever on proper use. For example: "the AIRSTREAM is too heavy" is a purely acceptance-related comment. Non-proper use, such as lifting the visor or disconnecting the fan, will not change the weight of the device, thus there should not be any connection between weight and proper use. The simple reasoning described here was not contradicted by statistical tests.

Comments were given in response to several different questions. One may distinguish between comfort-related comments (Question 4), visor-related (Q5), hindrance-in-work (Q7) and general comments (Q12). The total number of miners who provided comments was 186. The comments received are listed in Part B, Section 6.2.

2.2.2 Comments Related to Proper Use

Among the most frequent comments were: the visor fogs up; the AIRSTREAM can not cope with hard work or sweating; more air-flow is needed. They relate to different aspects of the same phenomenon, which may be called inadequate fan performance. Comments of this kind dominated in the visor-related and hindrance-in-work sections, their share was smaller among the comfort-related and general comments. The total number of comments belonging to the "fan performance poor" category was 249, larger than the number of miners who provided comments. This abundance of comments led to a loss of discriminating power: even though fan performance and proper use ought to be associated, the association did not manifest itself as an association between the number of comments and use. In other words, the analysis was swamped by practically everyone making a comment on poor fan performance.

Interestingly, it was the driver-equipment-operator group, who was the most concerned with fan performance: the proportion of air-flow related comments from this group was significantly larger than the proportion of users it represented. It appears they may have commented in the name of the other groups who do hard physical work more often.

When the comments from the driver-equipment-operator group were excluded from the analysis, an association appeared, as expected, between the frequencies of comments on fan performance (received from the other job categories) and job category or use category. Less use was correlated with more complaints.

The comments indicate that miners who appreciate the dust protection and eye/face protection provided are among the better users. Thus, motivation contributes to proper use. There was a lack of statements on dust/face protection from the driver/operator group, probably because they need it less in the course of their work than other groups.*

The principal reason for wearing the AIRSTREAM, namely the protection from radon/thoron daughters, had not been touched upon by the survey and was not referred to at all in the comments. It remains an open question to what extent miners are informed of prevailing radon levels and motivated by these levels to use the protection properly. Dust filtration is more visible and convincing than radon daughter removal.

Working levels in the stopes are likely to be higher than in other areas which are part of the ventilation path. The data collected did not provide an answer whether stope miners, who were the best users, were motivated to use the protection by the higher working levels they encounter.

The frequency of comments about visor-related problems (other than condensation) paralleled the extent of use. This indicates these problems become more significant during regular use, but they are not serious enough to become a deterrent that causes miners to abandon habits of proper use.

2.2.3 Comments Related to Acceptance

The principal comments related to acceptance were: the AIRSTREAM is too heavy; too bulky; work is hindered when bending down and in confined areas; the airstream falls off or gets knocked off.

The frequencies of acceptance-related comments were not associated with use. There appeared to be more general complaints (too heavy, etc.) from the casual users and more statements labelled as "AIRSTREAM Syndrome" (head/neck aches, motor noisy, headband irritates skin, etc.) from the better users. However, these associations were not statistically significant.

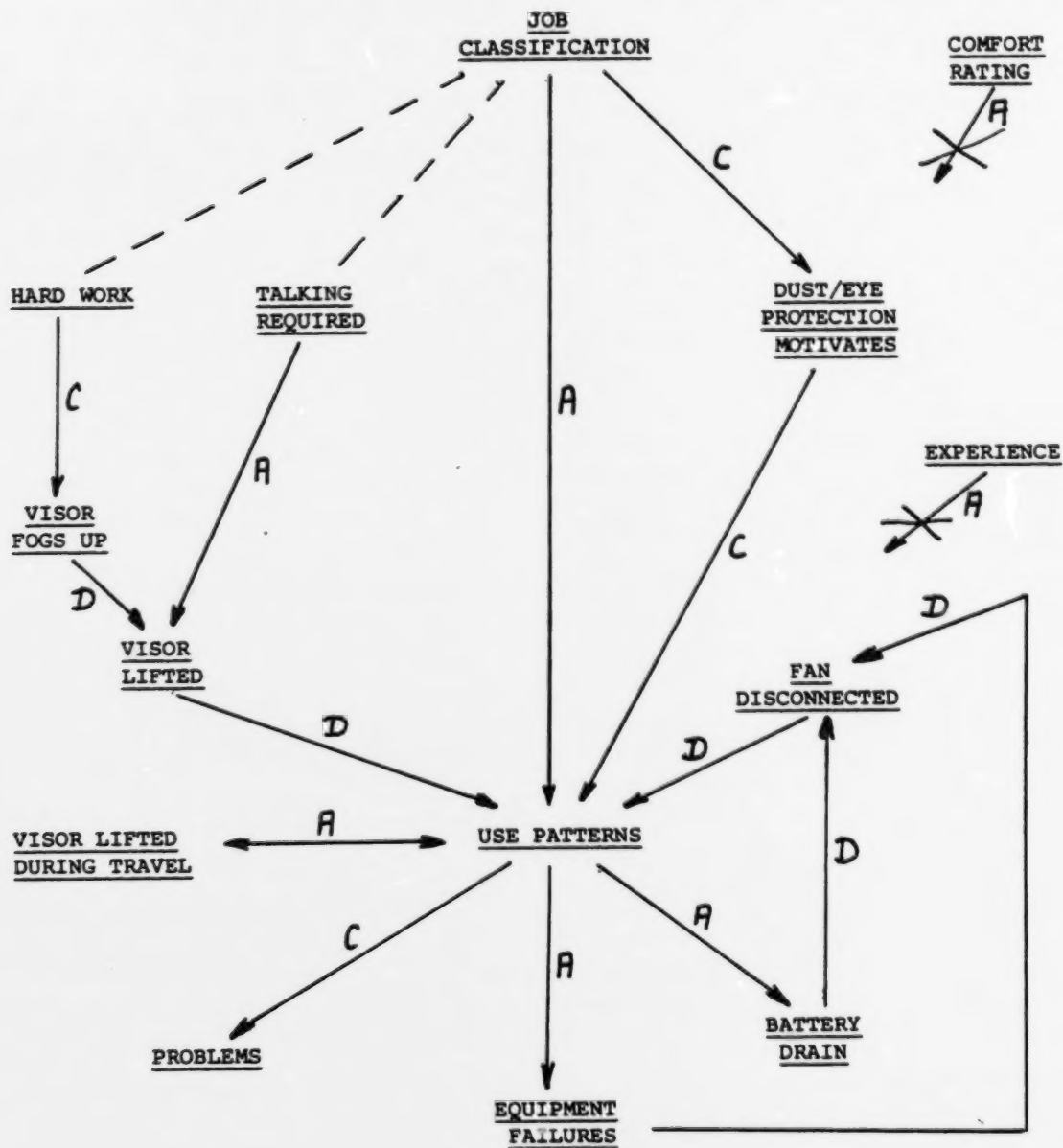
A number of the shortcomings stated were to some extent job-specific: confined spaces appear to be a problem mainly tradesmen encounter; drivers have more problems than others with the power cable getting caught or tangled; etc.

3. Conclusions

The relationships, established by this work, between proper use and other factors, are shown in Figure 1.

* They may encounter less dust or may be protected by windshields or cabins.

Figure 1: Relationships between Use Patterns and Other Factors



A - Analysis of Answers
C - Analysis of Comments
D - Deductions

Job classification is the principal factor that determines use patterns. The extent of proper use is above-average in the stopes and below-average by conveyor and rockbreaker operators, tradesmen/servicemen, and by leaching attendants*.

Statistical analysis indicates that the use patterns of new users (18 months with AIRSTREAM) are not job-specific. Thus miners settle into job-specific use patterns quite slowly. This could indicate that the influence of fellow workers may be a factor as important as the nature of the job, because one would expect a faster adaptation to the latter.

Hard work or physical exertion results in an increased breathing rate with which the respirator can not cope, its visor fogs up and has to be lifted. Talking requires as well the lifting of the visor. No other connection between job and proper use has been identified, except that motivation by the dust and eye protection features of the AIRSTREAM appears to contribute towards increased proper use.

About half of the miners travel to their workplace with the visor up; this appears to be a part of the overall use pattern instead of being a determining factor.

A number of findings or observations were found to be dependent on the extent of use: the occurrences of equipment failure, the observation of battery drain in the course of the shift, and use-related problems with visor, headband etc., all paralleled the extent of use.

On the basis of the failure data one can conclude that some miners disconnect the fan during parts of the work-shift. This constitutes a second kind of improper use, in addition to visor-lifting, on which previous studies have focussed.

A number of factors, such as comfort, experience, hindrance at work (other than fogging), have no influence on proper use. This is readily explained by recognizing that these factors affect not use but acceptance (participation in the voluntary program).

The effect of job classification on improper use and the distributions of improper use have been quantified.

4. Recommendations

Recommendations on the design of follow-up users' surveys are given here in general terms, because there is a multitude of feasible designs and the proper choice of design will depend on survey objectives which may evolve with time.

It is suggested that future studies of respirator use extend their scope beyond the user population, that they explore the reasons for acceptance or non-acceptance and explore the possibilities of improving acceptance and participation in the respirator program. Therefore recommendations that relate to an acceptance survey are also included.

* One possible conjecture - independent of the survey data - is that some jobs involve more logistics-related waiting and travel times than others, and that visors are lifted during these periods.

The listing below starts with some suggestions on improving the respirator, based on the comments analyzed.

Respirator Improvements Suggested

- (1) It appears important to solve the fogging problem. The use of a two-speed fan (top speed for hard work, normal speed for saving battery) or of a heater wire in the visor may be explored.
- (2) A better seal between the top of the helmet and the visor, which keeps out dust and moisture, would improve proper use.
- (3) An investigation of the battery drain had been recommended (1).
- (4) The falling off of the helmets appears to be a problem even though chin straps are available. A review of this situation is suggested.

Users' Survey Recommendations

- (5) When assessing proper use, a more restricted time-frame is suggested: In addition to questions that explore the usual pattern of use, one should ask what happened in the course of the last previous full shift worked. (For how long was the visor lifted? For what reasons? Was the fan disconnected?)
- (6) List reasons for improper use and ask miners to identify and rank the ones responsible for improper use - (usually, and in the course of the last previous shift).
- (7) Explore motivation - have miners state or rank their views on the importance of radon daughters, dust and face/eye protection by the AIRSTREAM. Explore how well informed the miners are about prevailing Working Levels and what is the usual range of Working Levels in their usual work environment.
- (8) Design questions that can lead to a better assessment of the extent and impact of: visor fogging, battery drain, talking/working with a partner.
- (9) Prompted answers are likely to be more suitable for statistical analysis than answers to open-ended questions. List some 20 frequently stated AIRSTREAM problems and ask miners to pick and rank the 5 most important ones.
- (10) It does not appear necessary to repeat Questions 4(comfort), 5(view), 6(talk) of the 1984 users' survey.
- (11) Encourage responding in French, if preferred.

Acceptance Survey

- (12) Ask a sample of drop-outs from the AIRSTREAM program and non-users to rank the reasons for not using the respirator. Explore the impact of comfort, motivation, hindrance in work, airflow, battery drain.

- (13) Using a survey sheet highly similar to the one described in Recommendation (12), survey a control group of users, asking them to rank their reasons for using the AIRSTREAM.

B. STATISTICAL ANALYSIS

1. Statistical Methods

1.1 General

The statistical analysis was done using SPSS software* and this software package is amply documented (2,3). For the sake of readability, statistical considerations will be often separated from the main body of the text and given as footnotes, except in this section.

A glossary of variable names is presented as Table 1-1.

1.2 Levels of Measurements

Most of the variables in this study were measured at the ordinal level: the order of values is meaningful, but differences or ratios of values do not have any meaning as a measurement. (Example: 1 = always, 2 = most of the time, 3 = sometimes). Many variables are dichotomies (2-valued, example: yes-no), but can be regarded as ordinal-level.

The variable JOB (job classification) is an exception; it is a nominal-level measurement because the order of the job codes is immaterial.

The variables USE (length of time with the visor down) and EXPER (length of experience with the AIRSTREAM) appear at first sight to represent a higher level of measurement than ordinal. If one had exact responses, they would be ratio-level. However, the responses collected are likely to be imprecise (note that "2-3 years" experience was coded as 30 months) and subjective. For example, the difference between the responses of "7 hours use" and 7-1/2 hours use" may reflect more a difference in the miners' attitudes toward the AIRSTREAM or toward the survey than a factual time difference of 30 minutes. Therefore it appears reasonable and prudent to regard EXPER and USE as ordinal-level measurements.

1.3 Selection of Tests

The usual analysis of variance, ANOVA, would require that the dependent variable USE be measured at least at the interval level. It was concluded in the previous section that this may not be the case; therefore, nonparametric

* SPSS - Statistical Package for the Social Sciences, Version 8.0 - June 18, 1979, Volgelback Computing Centre, Northwestern University.

Table 1-1: Glossary of Variable Names

JOB	job classification (answer to Question 1)
EXPER	experience with AIRSTREAM, months (Q.3)
COMFORT	comfort rating (Q.4)
VISION	view rating (Q.5)
TALK	opinion on feasibility to communicate with visor lowered (Q.6)
FAILED	AIRSTREAM failed in use (Q.8)
AIRFLOW	change in airflow observed (Q.9)
TRAVEL	travels to workplace with visor down (Q.10)
USE	hours of use with visor down per shift (Q.11)
NONUSE =	7.5 h - USE
USECAT	classes of USE
JOBCAT	job categories
STOPE, EQUIPM, SERVICE, MUCK are job category names	

statistics, which test on the basis of ranks* or medians, were preferred to ANOVA. The non-parametric tests employed were appropriate for ordinal-level data.

Late in the course of the study the transformation of USE into NONUSE was discovered. NONUSE is lognormally distributed and can be regarded as a ratio-level measurement. These characteristics made ANOVA of NONUSE feasible.

It was convenient in some cases to group data for treatment by crosstabulation or contingency tables because these could provide more measures of association than the nonparametric tests.

1.4 Measures of Association and Significance Levels

Among the results of most tests were the value of chi-square, χ^2 , and its significance. Chi-square is a measure of statistical independence, and significance indicates the probability of the data arising by chance instead of being a result of the cause studied. A low value of chi-square and high significance indicate a lack of association.

The chi-square test was used for a yes-or-no screening for association. The test value of significance chosen was 0.05; whenever the significance of chi-square was less than this value the variables were declared associated and whenever it exceeded 0.05 "no association" was concluded.

While appropriate for screening, chi-square is not a very useful statistic for measuring the strength or importance of association. There is a multitude of other statistics devised for this purpose (and computed by SPSS), and two such measures were chosen to be used in this work: Lambda and Gamma. They are appropriate for ordinal level data; they are appropriate for tables of any shape; and they appear somewhat easier to interpret than other statistics.

Lambda is the less powerful statistic, it requires only nominal-level data. It measures the improvement in our ability to predict the value of the dependent variable once we know the value of the independent one. Lambda can take values between 0 and 1 and the value 1 would mean that one can predict without error.

Gamma can be regarded as the probability of ordering correctly a pair of values of one variable once the ordering of the values of the other variable is known. Its sign indicates whether the ordering is concordant (for example, more experience is associated with more USE) or discordant (negative gamma; less experience - more USE). Gamma can have values between -1 and +1.

* Ranks are integer values assigned to each member of the population according to the order of values of a variable. For example, the ranking according to use implies the assignment of ranks 1-3 to the three miners who stated the least use (0.5 hours), 4-6 to the three who stated 1 hour, and so on. The number of valid answers was 204, therefore the highest rank will be 204 and the mean rank for the whole group will be $205/2 = 102.5$.

1.5 Limitations

The fixed-form data is characterized by the presence of a demand implicit in the questionnaire: "give a number" or "circle a number", and by the relatively low proportion of missing answers. Statistical analysis ought to be quite straightforward and reliable.

The situation is quite different when it comes to analyzing the free-form answers or comments. The frequencies of some comments received are probably highly different from the frequencies of affirmative responses one would collect if there had been a question asked. Care will be required in the use of statistics when analyzing the comments.

2. Association Between Job and Proper Use

2.1 General

In this section the review and regrouping of the job classification answers is described. The tests that indicate a strong association between JOB and USE are reported. Job categories are constructed and the relation of JOBCAT to USE is examined.

2.2 The Coding of Job Classification Responses

The job classification responses were not suitable, as received, to be fed into the statistical analysis. First of all, there were too many different jobs and consequently an insufficient sample size to include each particular job in the analysis. (There were, for example, 1 Skiptender, 2 ANFO Loaders, etc. in the sample). It appeared undesirable to exclude all these minority occupations from the analysis by grouping them into a "miscellaneous" category. Instead, it was attempted to group together several occupations whose job situations and work environments did not appear too different.

Additional problems encountered were multiple answers (e.g. "scoop and truck"), very general ones (e.g. "operator"), and ones that required deciphering (e.g. D-6, Teledyne, etc)(4).

The different job classification answers were coded and grouped into 11 JOB codes and 3 categories of discarded or missing answers. After the regrouping, the median USE for each subgroup was used as a control to indicate that no "homogenization" occurred by mixing essentially "casual" user groups with more motivated ones.

2.3 The Effect of Job on Use

The Kruskal-Wallis (K-W) nonparametric one-way analysis of variance* was used to test the association between USE and JOB codes. The significance of chi-square was less than 0.001, thus association was confirmed beyond doubt.

Table 2-1 presents descriptive information on the extent of USE by different JOB's.

* The K-W test tests for difference in medians. It is more powerful than the median test, because it makes use of the rank value of each case.

TABLE 2-1: The Extent of Use by Different Job Classifications

JOB			USE, hours			
Code	Label	No. of Miners	Mean Rank*	Lower Quartile	Median	Upper Quartile
11	Driller, Bolter, Loader	18	143	6.5	7	7
12	Miner	11	135	6	7.5	7.5
23	Truck-Haulage Op.	25	123	6	6.5	7
62	Multiple Jobs	6	119	6	6	7.5
21	Heavy Equipment Op.	25	108	6	6	7
22	Scoop Op.	33	103	5	6	7
32	Vehicle Op.	12	103	4.5	6	7
63	Job not given	5	102	6	6.5	6.5
33	Service, Labour, Misc.	15	99	5.5	6.5	6.5
61	Undefined	8	85	5.5	6	6
41	Conveyor Op.	17	79	3	5.5	7
31	Tradesman	17	78	4	6	6.5
51	Leaching Attendant	4	51	(5)	(5)	(6)
42	Rock Breaker Op.	11	42	1	4.5	6

* Individual responses were ranked according to length of use and the mean values of these ranks, computed for each group, are shown here.

2.4 Further Regrouping into Job Categories (JOBCAT)

The populations of many of the eleven JOB classes were still too low, therefore a further regrouping into job categories JOBCAT was made. The intent was to improve and simplify subsequent statistical analysis. Each JOBCAT was tested for the absence of significant differences in USE among the JOB groups amalgamated into the category, see Table 2-2. A description of the job categories follows.

2.4.1 STOPE (29 persons)

This category groups workers who work primarily on ore production in the stopes. It comprises 18 Drillers, Bolters, Loaders and 11 Miners. (It is hoped the "miner" answers mean stope miner and not the generic "uranium miner".)

2.4.2 EQUIPMT (88 persons)

This is the largest user group. Their common characteristic is riding on heavy equipment, scoops or trucks. The jobs and the extent of respirator use appear sufficiently similar to allow the grouping of 25 Heavy Equipment Operators, 33 Scoop Operators and 25 Truck-Haulage Operators into one category, even though the populations would be large enough to be treated separately.

2.4.3 SERVICE (44 persons)

This group is characterized by mobility, and diversity of work places and jobs. It includes 17 Tradesmen/Journeymen, 12 Utility/Service Vehicle Operators and 15 persons who are mainly Servicemen, Labourers, or had miscellaneous occupations that appeared to fit into the category.

2.4.4 MUCK Handling (28 persons)

Conveyor (17) and Rock-Breaker Operators (11) appear to be the most casual users of the AIRSTREAM. The two occupations are quite different: Rock Breaker Operators are stationary while Conveyor Operators move about. The relatively small size of each group and the similar use pattern are the reasons for combining the two occupations.

2.4.5 LEACHING (4 persons)

Leaching Attendants are the most exposed users in the group surveyed; they frequently enter areas of the mine where radon/thoron levels are high. This characteristic is the reason for considering them separately. However, the group is too small for being included in the statistical analysis. Their use pattern appears casual; one respondent stated he lowers his visor only in "high radiation areas" (coded as missing answer).

2.4.6 UNDEFD (19 persons)

The "undefined" group includes 5 persons who did not state what their job was. Their use pattern corresponds to the average of the population surveyed. Eight other answers were vaguely defined (e.g. operator), and 6 persons who

TABLE 2-2: Tests of Homogeneity within Job Categories (JOBCAT)

JOBCAT			Tests of USE by JOB			
Code*	Label	No. of Miners	Name**	Statistic	D.F.***	Significance
1	STOPE	29	M-W	$Z = 0.256$	1	0.798
2	EQUIPMT	83	K-W	$\chi^2 = 1.988$	2	0.370
3	SERVICE	44	K-W	$\chi^2 = 1.930$	2	0.381
4	MUCK	28	M-W	$Z = 1.534$	1	0.125
5	LEACHING	4				
6	UNDEFD	19	K-W	$\chi^2 = 1.148$	2	0.563

* The JOBCAT code is the first digit of the JOB code shown in Table 2-1

** K-W: Kruskal-Wallis Test

M-W: Mann-Whitney U - Wilcoxon Rank Sum W Test

*** DF: Degrees of freedom

gave multiple job answers, mainly in the EQUIPMT category, are included here as well for the sake of conserving the "purity" of the sample in the sufficiently large EQUIPMT groups.

2.5 The Association Between Use and Job Categories

Again, the Kruskal-Wallis one-way ANOVA was employed to test the association between USE and Job Categories JOBCAT. The significance of chi-square was 0.001 thus association was confirmed. Descriptive information on the extent of USE by different JOBCAT's is given in Table 2-3.

The order of the JOBCAT's, ordered according to extent of use and descending from full-time toward casual use is: STOPE, EQUIPMT, SERVICE, MUCK. Further statistical analysis will involve principally the above four categories*.

2.6 User Categories (USECAT) and their Association with Job Categories

It was convenient to be able to crosstabulate USE and JOBCAT, because this is the way the associations between JOBCAT and other factors will be analyzed. Therefore USE was grouped into three user categories USECAT as follows:

Cat. 1:	0.5 - 5.5 h use (casual users)	- 27.5%
Cat. 2:	6 and 6.5 h use (good users)	- 39.2%
Cat. 3:	7 and 7.5 h use (full-time users)	- 33.3%

The crosstabulation of USECAT by JOBCAT is reproduced as Table 2-4. Chi-square indicates a significant association and the rounded values of Lambda and Gamma are, respectively, 0.15 and -0.45.**

3. The Effect of Factors Other Than Job on Use

3.1 General

In this section factors other than JOB (or JOBCAT) will be tested for association with USE and for effect on USE. Only the fixed-form answers will be dealt with in this section; the analysis of comments is reported in Section 6.

The variable USE was tested for association with other factors, which were extracted from responses to the different questions of the survey questionnaire.

Non-parametric tests (K-W or M-W)*** were used, and the results of the tests are presented in Table 3-1.

* Because of the ordering described here JOBCAT will be regarded as an ordinal level variable.

** The negative value of gamma tells that the ascending order of USECAT's (1,2,3) is correlated with the descending order of JOBCAT's (4,3,2,1).

*** Kruskal-Wallis one-way ANOVA; Mann-Whitney U and Wilcoxon Rank Sum W test.

Table 2-3: The Extent of Use by Different Job Categories

JOBCAT		USE				
CODE LABEL	No. of Miners	Mean Rank	Lower Quartile,h	Median h	Upper Quartile,h	Percent 6 h
1. STOPE	29	140	6.5	7	7.5	7
2. EQUIPMT	88	110	6	6.5	7	20
3. SERVICE	44	92	5	6	6.5	35
4. MUCK	28	64	2	5	6.5	61
5. LEACHING	4	51	(5)	(5)	(6)	(67)
6. UNDEFD	19	100	6	6	7	21

Table 2-4: Crosstabulation of Use by Job Categories

USECAT	COUNT COL PCT	JOB CAT				ROW TOTAL
		ISTOPE	EQUIPMENT SERVICE	MUCK HAN DLING		
LOW 5-5.5	1.	1. 6.9	2. 19.5	3. 15	4. 17	50
GOOD 6,6.5	2.	1. 37.6	2. 41.5	3. 44.2	4. 17.9	69
FULL 7,7.5	3.	1. 55.5	2. 39.0	3. 20.9	4. 21.4	63
COLUMN TOTAL		29 15.9	82 45.1	43 23.6	28 15.4	182 100.0

RAW CHI SQUARE = 29.90612 WITH 6 DEGREES OF FREEDOM. SIGNIFICANCE = .0000
 LAMBDA (ASYMPTOTIC) = .15044 WITH USECAT DEPENDENT.
 LAMBDA (SYMMETRIC) = .08451
 GAMMA = -.44681

NUMBER OF MISSING OBSERVATIONS = 2

Table 3.1: Tests of Association between Use and Other Factors

FACTOR		TESTS			
Question No.	Code	Name*	Statistic	D.F.**	Significance
1	JOB	K-W	$\chi^2 = 36.69$	13	0.001
2	JOB CAT	K-W	$\chi^2 = 29.40$	5	0.001
3	EXPER	K-W	$\chi^2 = 1.52$	3	0.677
4	COMFORT	K-W	$\chi^2 = 2.75$	3	0.432
5	VISION	K-W	$\chi^2 = 3.26$	3	0.354
6	TALK	K-W	$\chi^2 = 2.93$	2	0.231
8	FAILED	M-W	$Z = 2.55$	1	0.011
	SERVICE	M-W	$Z = 0.25$	1	0.802
9	AIRFLOW	K-W	$\chi^2 = 5.51$	3	0.138
10	TRAVEL	M-W	$Z = 4.32$	1	0.0001

* K-W: Kruskal-Wallis; M-W: Mann-Whitney

** Degrees of freedom

3.2 Factors Not Significantly Associated with Use

3.2.1 EXPER: Length of Experience with AIRSTREAM

The responses to "How long have you been using the Airstream?" have been grouped into four classes as follows; 1-15 months (23.5%); 18-24 months (28.5%); 30-42 months (21.5%); and 4-7 years (26.5%). The significance of Chi-square from the Kruskal-Wallis test of USE by EXPER was 0.677, well in excess of test value of 0.05 significance. The conclusion is: no association.

3.2.2 COMFORT: Responses to Question 4

Question 4 was: "Do you find the AIRSTREAM comfortable to wear?" The COMFORT rating, which was given on a time scale ("Always - Most of the time - Sometimes - Never") was found not to be associated with USE. This surprising finding is the result of the K-W test which gave 0.432 significance of Chi-square. The median ranks of USE for the three more "Comfortable" groups were 99, 104 and 100 - in descending order of comfort, while the 10 persons "never comfortable" ranked 73 on this scale. This trend reflects indeed common sense; however, the difference is not statistically significant.

An additional test was made to see if USE by the "never comfortable" group differed significantly from the rest of the respondents. The difference was not significant at the 0.05 level. Thus comfort may have an impact on use, but this impact appears limited to about 5% of the user population.

The explanation is probably that a choice or selection had already been made by the miners: the ones who were really not comfortable with the AIRSTREAM had ceased to be users, and were not among the population surveyed.

3.2.3 VISION: The Quality of View Through the Visor

The responses to Question 5 - "How do you rate the visibility of the AIRSTREAM?" - and USE were statistically independent. (The significance of the K-W Chi-square was 0.35). Only 3 persons rated the view as "poor".

3.2.4 TALK: Lifting the Visor when Talking

Again USE and the answers to Question 6 - "How often do you find you must lift the visor when talking?" - were statistically independent. (The significance of the K-W Chi-square was 0.23). The mean ranks of use indicate a trend: more lifting goes with less use. They were 112 for the ones who answered "sometimes", 106 for "most of the time" and 95 for "always". However, the null hypothesis of no difference in USE can not be rejected.

It is believed that communicating or working with a partner may give rise to a significant reduction in the extent of proper use. The survey responses confirmed overwhelmingly that the visor must be lifted if one wants to be heard and understood. Unfortunately, the question was not followed by one designed to measure the frequency or amount of communication requirements.

3.2.5 AIRFLOW: Drop in Airflow During the Shift

The effect of AIRFLOW on USE, as measured by Question 9 "Do you ever notice a change in the airflow of the airstream?", was not significant at the 0.05 level. The significance of the K-W Chi-square was 0.138, but the trend was: the less airflow the more use. Therefore, obviously AIRFLOW (i.e. noticing the drop in flow) is dependent on USE and not the other way. The mean ranks of USE were 88 for the ones who "never" noticed a change, and 106, 113, 110, respectively, for the "sometimes", "most of the time", and "always" answers. This slight trend seems to corroborate the honesty of the answers received. An even stronger proof of consistency is to be found in Section 3.3.

3.2.6 SERV: The Quality of Service

The question was "Was the servicing after failure satisfactory?" and only 10 persons answered "no". The extent of use by these persons did not differ from the "yes" group. (Mean ranks were 53 and 50, and the significance of the M-W Z was 0.08).

3.3 Factor that Depends on Use: Encountering Equipment Failure

A strong association was found between USE and the answers to Question 8: "Has your AIRSTREAM ever failed in use?" The significance of the M-W Z was 0.011, well below the test value of 0.05. If equipment failure influenced use one would expect more failures to be associated with less use, but this was not the case: the ones who reported more use encountered more failures. The mean ranks by use were 89 for the "no (failures)" group and 110 for the "yes (it failed)" group. Thus, encountering equipment failure depends on the extent of use and not the other way around. The result, along with the AIRFLOW observations, indicates that survey responses were honest and consistent.

One should remember at this point that USE does not signify the wearing of the respirator, but rather proper use of it - with the visor down. The lifting of the visor can in no conceivable way influence the frequencies of failure as described above. Therefore, there must be some other important form of improper use, which is of a kind that can reduce equipment failures. Considering it unlikely that the helmet is taken off and not worn, it was concluded that casual users not only lift the visor, but also disconnect at times the AIRSTREAM from the power-pack.

3.4 The Effect of TRAVEL - Travelling with the Visor Down - on Use

TRAVEL - travelling to the workplace with the visor down - is the only other factor besides JOB, among the ones examined by the survey questions, that has a significant effect on use. Question No. 10 of the survey was: "When travelling to and from the cage and your workplace/lunchroom, do you wear your visor up or down?" When ranked according to use, the mean rank of the "up" group was 82 and of the "down" group 116. The M-W test indicated a significant difference: the significance of the Z statistic was less than 0.0001.

A crosstabulation of usage category by TRAVEL is presented in Table 3-2. Lambda indicates that travel with the visor down may be the dependent variable instead of user category: Lambda equals 0.24 with TRAVEL dependent and 0.15 with USECAT dependent. Gamma was 0.46. The above values were quite similar to the results of the USECAT BY JOBCAT crosstabulation.

Table 3-2: Crosstabulation of Use Category by Travel

USECAT	COUNT COL PCT	TRAVEL		ROW TOTAL
		NO	YES	
LOW 5 5.5	1.	29 34.5	19 20.2	48 27.0
GOOD 6,6.5	2.	38 45.2	29 30.9	67 37.6
FULL 7,7.5	3.	17 20.2	46 48.9	63 35.4
COLUMN TOTAL		84 47.2	94 52.8	178 100.0

KAM CHI SQUARE = 16.13061 WITH 2 DEGREES OF FREEDOM. SIGNIFICANCE = .0003
 LAMBDA (ASYMMETRIC) = .15315 WITH USECAT DEPENDENT.
 LAMBDA (SYMMETRIC) = .18462
 GAMMA = .43673

NUMBER OF MISSING OBSERVATIONS = 6

4. Analysis for Relative and Combined Effects

4.1 General

In Sections 2 and 3 the effects of the different factors were examined individually. This section examines the relative contributions to non-use of the factors considered and the possibility of combined effects.

It occurred late in the course of the study that the USE distribution shown in Figure 1 may well correspond to a lognormal distribution of NONUSE, which is the difference between 7.5 hours and USE. It will be shown this is indeed true and therefore the variable NONUSE is suitable, after a logarithmic transformation, for being tested by standard Analysis of Variance (ANOVA).

4.2 Controlled Crosstabulations

The principal finding of Sections 2 and 3 was that USE depended strongly on JOBCAT and on visor lifting during TRAVEL, and very little or not at all on the other factors. Crosstabulations were made of USECAT by TRAVEL, controlling for JOBCAT (i.e. tabulating separately for each job category), and the reverse as well: USECAT by JOBCAT controlled for TRAVEL. Table 4-1 summarizes the results.

The crosstabulations show that AIRSTREAM use is strongly associated with job category regardless of traveling to the workplace with the visor up or down (Part B of Table 4-1).

The situation is more complicated when the lifting of the visor during travel is examined for each job category. (Part A). USE is strongly associated with TRAVEL in the STOPE and EQUIPM categories only. There is no association found in the SERVICE category and there may be some in MUCK, but also there is an indication that the general usage pattern and attitudes determine whether the visor is lifted or not during travel. This type of analysis - discriminating between job categories - will be continued in Section 5.

4.3 The Distributions of Non-Use

NONUSE was defined as 7.5 hours minus the hours of use with the visor down. The cumulative distributions of NONUSE (on a logarithmic scale) of the entire sample population and of the four job categories are shown in Figure 2. Figure 3 shows the distributions of the visor "up" and "down" TRAVEL categories.

The straight lines in the figures were fitted by eye to the data in the range of 1 to 5 hours of NONUSE. The high end data drifts away from the theoretical distribution that would imply that a few miners (1-2%) wear the AIRSTREAM without ever lowering the visor.

At the low end, the 0.5 hour NONUSE (7 h USE) data is below the straight lines, but could be shifted right onto the line in each case if one assumes that the "7 hours" survey answer meant 40 minutes visor lifting per shift instead of the more rigorous 30 minute value. Similarly the values for the "7.5 hours" reported use (note that 0 NONUSE can not be plotted on a log scale) would meet the lines at the 20 minute mark. This indicates that even "perfect" users are likely to lift the visor about 20 minutes/shift (excl. meals) at the workplace.

Table 4-1: Controlled Crosstabulations

		Lambda		
Control	P(Chi-Square)	USECAT dep.	Other dep.	Gamma
A. <u>USECAT - (Usage Category) by TRAVEL - (Travel with Visor Down)</u>				
JOBCAT = STOPE	0.044	0.27	0.30	0.78
EQUIPM	0.004	0.25	0.31	0.47
SERVICE	0.74	*	*	*
MUCK	0.11	(0)	(0.36)	(0.65)
B. <u>USECAT by JOBCAT</u>				
TRAVEL = NO (up)	0.007	0.20	0.04	0.45
YES (down)	0.005	0.27	0.30	0.78

* not applicable

Proper Use
h / shift

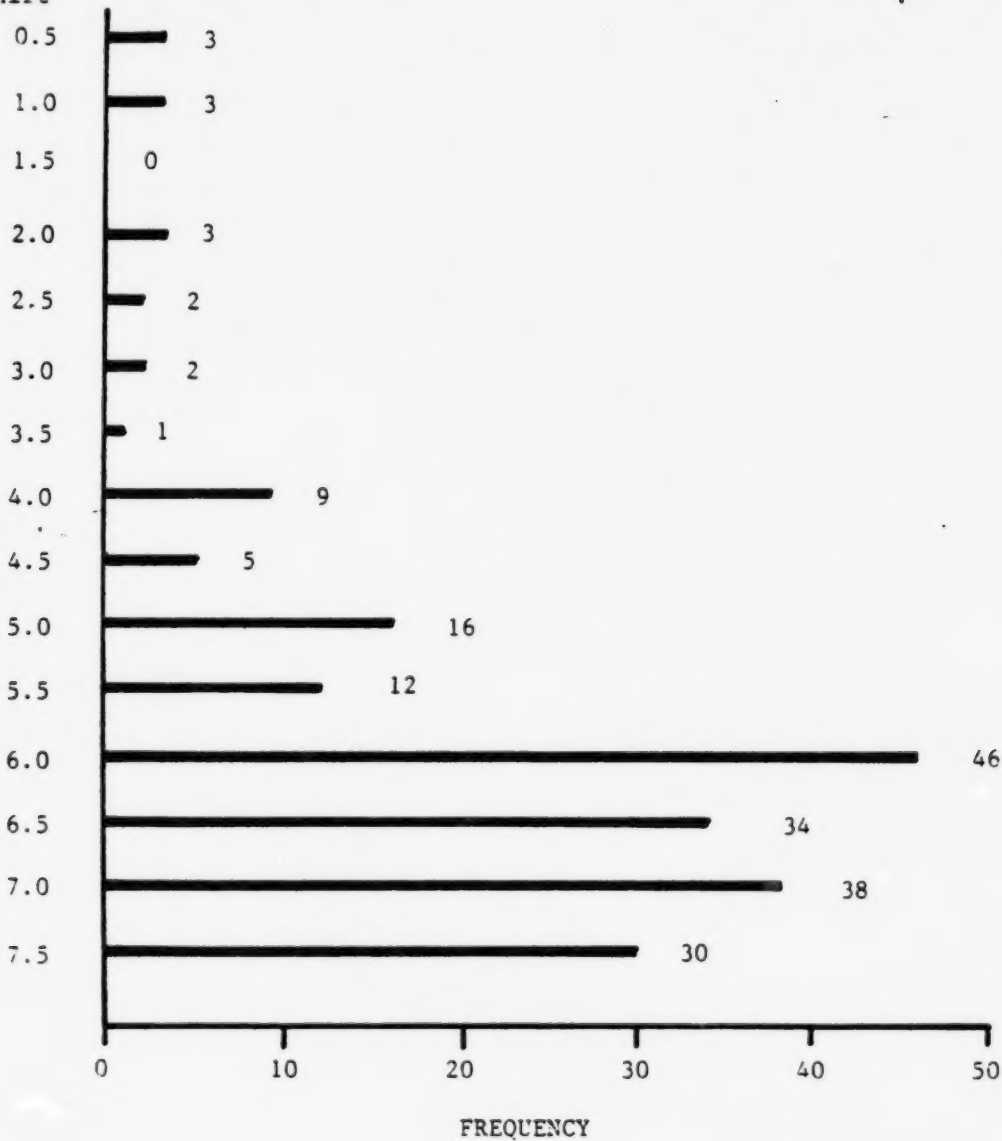


Figure 1: Histogram of the Duration of Proper Use Responses

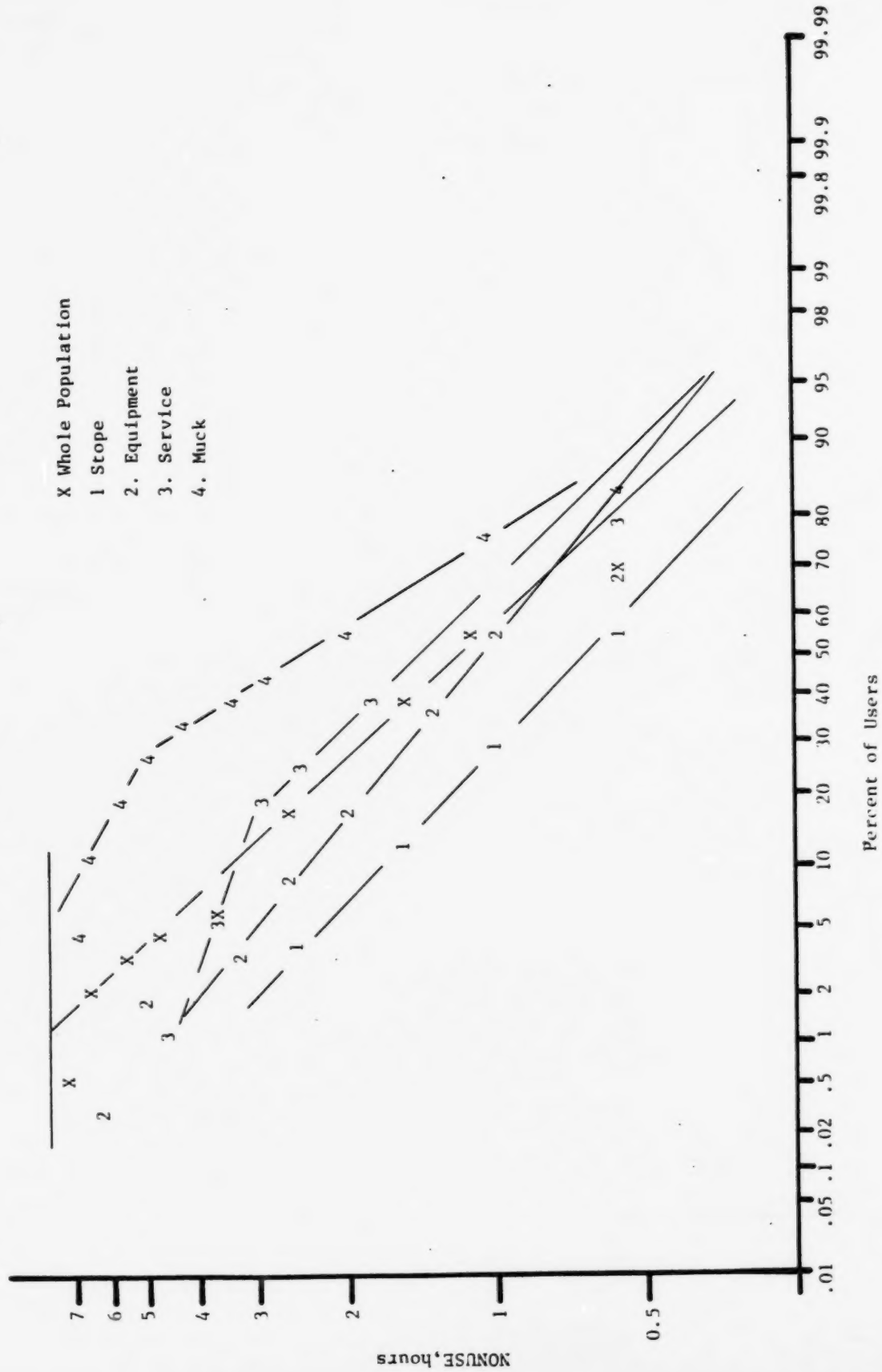


Figure 2: Cumulative Distribution of Non-Use. Job-Dependence.

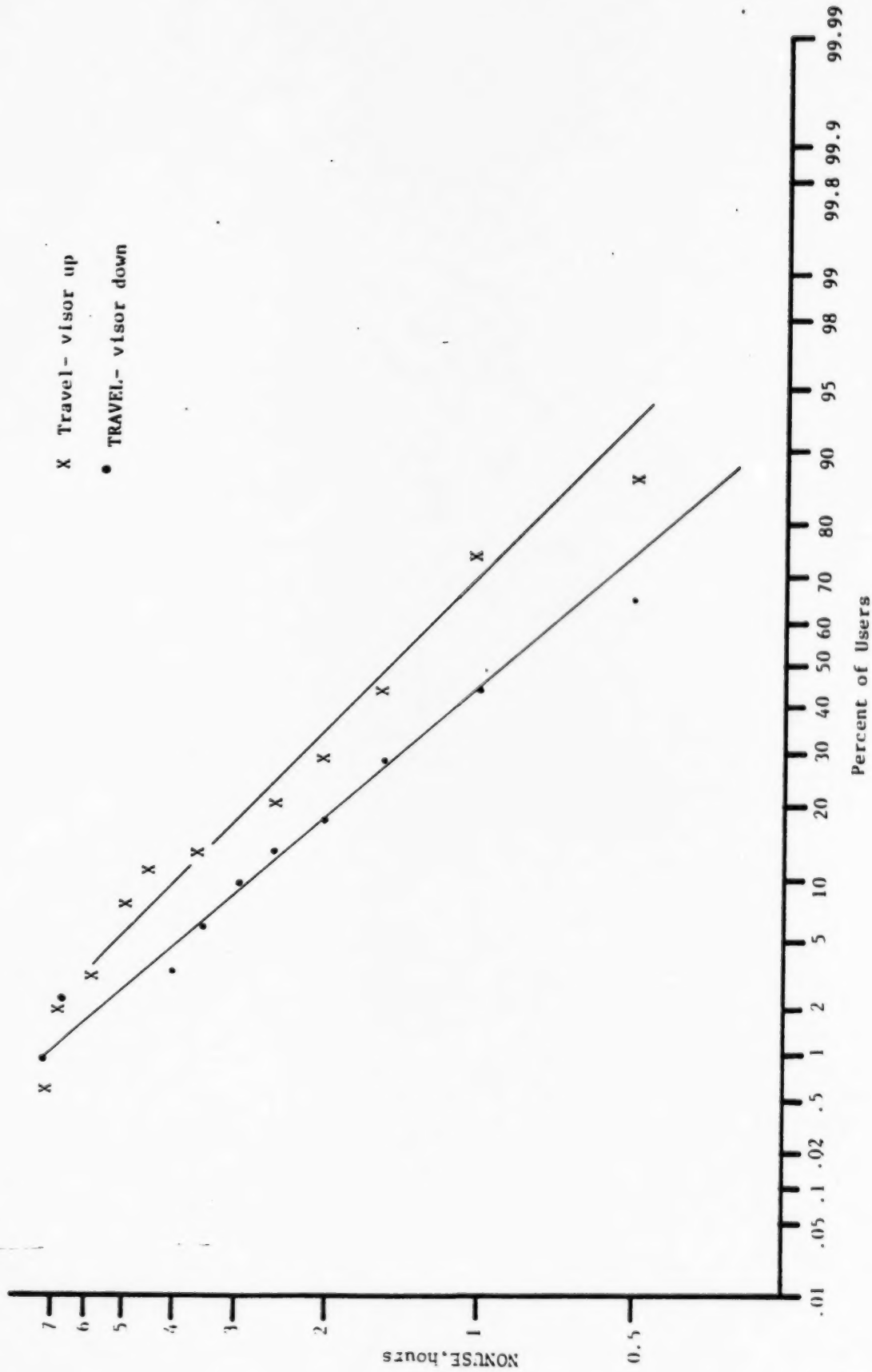


Figure 3: Cumulative Distribution of Non-Use. Dependence on Visor - Lifting During Travel.

The distances between the lines, at the 50% mark, may be used to measure the relative contributions of the JOBCAT and TRAVEL factors to non-use. But graphic methods are not necessary, because having found a normally distributed set of data (the logs of NONUSE) standard analysis of variance becomes feasible.

4.4 Analysis of Variance (ANOVA)

In line with the findings of the previous section, the "7 hours" and "7.5 hours" use answers were recoded, respectively, as 40 minute and 20 minute NON-USE. After this recoding the logarithms of NONUSE were subjected to ANOVA.*

First, ANOVA of NONUSE by JOBCAT and TRAVEL was run. ANOVA confirmed, as shown in Table 4-2, that the effects of these factors are significant. Jointly they explain 25% of the variance of NONUSE; individually the effect of JOBCAT is 18% and of TRAVEL 9%; the interaction or dependence of JOBCAT and TRAVEL amounts to 3% of the variance.

The geometric grand mean of NONUSE is 1.15 hours.

The effects of the individual factors, after adjustment for the effect of the other, are:

TRAVEL with visor up:	x 1.26	NONUSE
" " visor down:	x 0.81	" **

(Thus the apparent travel time is $1.15 \times 0.45 = 0.5$ hours)

JOBCAT = STOPE:	x 0.60	NONUSE
EQUIPM:	x 0.91	"
SERVICE:	x 1.10	"
MUCK:	x 1.82	"

The first ANOVA run was followed by others in which the factors EXPERIENCE, COMFORT, VISION, TALK were introduced one by one. The first three had no effect, not even at the 0.25 significance level. Only TALK may have a slight effect on NONUSE (significance of F 0.13; explains 2% of the variance, but TALK being somewhat dependent on JOBCAT and TRAVEL its overall contribution was only 1%).

No tests were made for the factors which were found to depend on use: FAILED and AIRFLOW.

* ANOVA decomposes the variation (sums of squared deviations from the mean, SS) of a dependent variable (here: NONUSE) into SS due to independent variables, called factors (here: TRAVEL, JOBCAT, etc.), the sum of which is "SS Explained", and into a "Residual SS". The difference between the mean of the values of the dependent variable associated with a value or category of a factor and the grand (or overall) mean is called the effect of the factor. The appropriate statistic for testing whether an effect is significant is the F-test.

** Thus, travel with the visor up increases NONUSE to 126% of the grand mean and travel with the visor down decreases NONUSE to 81% of the grand mean.

Table 4-2: ANOVA of NONUSE by JOBCAT and TRAVEL

***** ANALYSIS OF VARIANCE *****
 BY NONUSE HALF-HOUR PERIODS WITH VISOR LIFTED
 TRAVEL TRAVELS WITH VISOR DOWN
 JOBCAT JOB CATEGORY

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF F
MAIN EFFECTS	5.220	4	1.305	14.572	.001
TRAVEL	1.534	1	1.534	17.132	.001
JOBCAT	3.339	3	1.113	12.427	.001
2-WAY INTERACTIONS	.726	3	.242	2.704	.047
TRAVEL JOBCAT	.726	3	.242	2.704	.047
EXPLAINED	5.947	7	.850	9.485	.001
RESIDUAL	15.225	170	.090		
TOTAL	21.172	177	.120		

184 CASES WERE PROCESSED.
 6 CASES (3.3 PCT) WERE MISSING.

5. Job Category Profiles

5.1 General

In this section the job categories will be examined one by one in an attempt to find what else besides use patterns and work situations discriminated them.

5.2 Descriptive Statistics

The descriptive statistics of the answers to several survey questions are summarized in Table 5-1.

One finds that miners in the SERVICE category have less experience with the AIRSTREAM than others. They are either more recent users or more recently hired.

There is no difference in the responses to the questions related to COMFORT and VIEW. Equipment operators differ slightly with regard to the feasibility of TALK (communicating through the visor); the majority stated that the visor must be always lifted for talking. The TRAVEL pattern is identical for three groups - 50% with visor up, 50% with visor down - but the STOPE category differs: more people (63%) travel with the visor down.

AIRFLOW - noticing the drop in airflow, is consistent with the different extents of use and so is the probability of encountering equipment failures.

A rough adjustment of the "no failures" fractions can be made for the differences in experience. Multiplying them with the mean experience of each JOBCAT yields a characteristic time with no failures*. This mean time may be multiplied by the average use of the group to yield a characteristic time of use with no failures. The purpose of these rough calculations tabulated in Table 5-2 is to explore which jobs result in most wear or beating of the equipment: the ranking appears to be SERVICE, STOPE, EQUIPM, MUCK.

5.3 Controlled Crosstabulations

5.3.1 General

The findings of Section 4.2 may be repeated here: USECAT depends on JOBCAT regardless of the value of travel; but USECAT depends on TRAVEL only in the STOPE and EQUIPM job categories.

Other crosstabulations with controls, similar to those of Section 4.2 were made involving variables other than TRAVEL. Thus USECAT was tabulated against JOBCAT using a third variable as control, and against the third variable using JOBCAT as control.

* Different from MTBF, mean time between failures, because "yes" answers correspond often to several failures.

Table 5-1: Descriptive Statistics of Survey Answers by Job Categories

FACTOR	Mark or Answer*	JOBCAT			
		STOPE	EQUIPM	SERVICE	MUCK
EXPER, months	LQ	18	24	6	24
	MED	36	24	24	36
	UQ	54	48	30	48
	Mean	37	33.5	21.1	36.6
COMFORT	LQ				
	MED				
	UQ				
VIEW	LQ				
	MED				
	UQ				
TALK	LQ				
	MED				
	UQ				
FAILED	No	24%	42%	43%	61%
	Yes	76%	58%	57%	39%
AIRFLOW	LQ				
	MED				
	UQ				
TRAVEL	No(up)	37%	47%	50%	50%
	Yes(down)	63%	53%	50%	50%

* LQ - lower quartile; MED - median; UQ - upper quartile

Table 5-2: Characteristic Times* with No Failures

JOB CAT	Elapsed Time, Months	Time of Use, Months
STOPE	8.9	8.0
EQUIPM	14.0	11.7
SERVICE	9.1	7.1
MUCK	22.3	13.4

* See text, Section 5.1

5.3.2 The Dependence of Use Category on Job Category

USECAT depends on JOBCAT regardless of the value of TRAVEL (as already stated) and of VISION*.

However, the crosstabulations show that the association of USECAT and JOBCAT disappears for certain specific cases (i.e. for certain specific subpopulations characterized by certain answers to some survey questions). These cases are:

- i. EXPER less than 18 months (52 miners):
USECAT by JOBCAT Chi-square = 5.07; D.F. = 6;
significance = 0.535.

This result shows that new users of the AIRSTREAM start out using it to an extent (which is somewhat lower than the average for all miners) that is not influenced by their job category. Their usage pattern is not assimilated to that of their JOBCAT initially; this assimilation appears to take a year or two. This long "incubation period" leads to the conjecture that proper use may be more related to the use pattern of fellow workers in the job category than to the nature of the job itself, specific to the category.

- ii. TALK - lifts "sometimes" visor when talking (38 miners):
USECAT by JOBCAT Chi-square = 6.42; D.F. = 6;
significance = 0.378.

The job and use association does not seem to exist in this group, which is contrary to the job-dependence found among those who answered the TALK question "most of the time" or "always".

Is the job-dependence of use related to the amount of talking at work? The non-job-specific group is quite small (38), therefore the crosstabulation result is not conclusive.

5.3.3 Job Category - Specific Effects on Use Category

The variables EXPER, VISION and TALK were tested and were found to have no association with USECAT in any of the job categories. Thus, the already stated effect of TRAVEL on USECAT (specific to the STOPE and EQUIPM categories) remains the only JOBCAT-specific effect.

5.3.4 Other Associations Tested

TRAVEL and JOBCAT are statistically independent (Chi-square = 1.32, D.F. = 3, significance 0.724).

The USECAT by TRAVEL association was controlled for COMFORT. The association is significant only for the groups who stated that the AIRSTREAM is "always" or "most of the time" comfortable. Interpretation is lacking. USECAT was independent of COMFORT regardless of the "up" or "down" value of TRAVEL.

* The data was sufficient only to test the "good" and "usually good" VISION values.

5.4 ANOVA of Non-Use within Job Categories

TRAVEL and one-by-one the variables EXPER, COMFORT, VISION, TALK were tested for their effect on NONUSE. These ANOVA runs, performed for each JOBCAT, did not produce any additional useful information and were not in contradiction with the findings already described.

6. Analysis of Users' Comments

6.1 General

This section describes what were the comments of "free-form" answers to the open-ended questions of the user survey. The frequencies of these comments are reported, as well as crosstabulations of the principal comments by job categories JOBCAT and categories USECAT.

The comments on the answer sheets were read and given an abbreviated code. This code was transferred into coding sheets and a computer file in a way that preserved the place of occurrence, i.e. the context in which the comment was made. These places were:

- Question 4 - Comfort-related comments
- Question 5 - View and visor-related comments
- Question 7 - Statements of hindrance in work
- Question 12 - General comments

Often, the same comment was repeated at several places in the form and this repetition was preserved by the coding.

The initial reading and coding resulted in a classification of the comments into 68 categories, plus a rating of any general subjective opinions stated on a poor-fair-good-excellent scale.

On the basis of the frequencies encountered, some of the less frequent comments were regrouped into larger categories. This compressed the number of categories that were entered in the computer file to 33. The description that follows will list all the "fringe" answers that disappeared in the course of this compression.

6.2 The Nature of Comments

6.2.1 The Most Frequent Comments

The following were the eight most frequent comments, which were each given by more than 20 miners (their order here is of no importance):

- 1 TOO HEAVY
- 2 MORE AIR NEEDED
- 3 BENDING DOWN uncomfortable or work is hindered
- 4 FALLS WHEN BENDING (the AIRSTREAM falls off)
- 5 VISOR FOGS UP
- 6 SWEATING interferes with view and work
- 7 HARD WORK - AIRSTREAM performance can not cope with it
- 8 CONFINED AREAS - AIRSTREAM is in the way and causes difficulties

Four of these frequent comments are related to respirator performance: the battery/fan combination does not always provide sufficient airflow (comments No. 2, 5, 6, 7). Three of them relate to hindrance in work that requires bending down, or in confined areas. One comment of the general type is found in this "top 8" category: many think the equipment is too heavy.

6.2.2 Comments Related to Fan Performance

- 2 MORE AIR NEEDED; incl: difficult to breathe (2)
- 5 VISOR FOGS UP
- 6 SWEATING
- 7 HARD WORK
- 9 ONLY FOR DRIVING (AIRSTREAM is not suitable for other type of work)
- 10 WALKING UPHILL leads to fogging

All these answers may be combined into a single phrase: More airflow is needed, because the visor fogs up whenever one works hard enough to sweat and to breathe fast.

6.2.3 Comments Related to Task and Position

- 3 BENDING DOWN
- 4 FALLS WHEN BENDING
- 8 CONFINED AREAS
- 11 CORD GETS TANGLED
- 12 UP OR DOWN TASK difficulty; drilling uphole/looking up (6); drilling or picking lifters (4); looking down (1)
- 13 MAINTENANCE AND CLEANUP difficulty
- 14 MATERIAL HANDLING LOADING difficulty
- 15 MUCKING WATERING visor fogs up in humid environments; mucking (3); washing muck/watering (9)
- 16 SHOVELLING SCALING difficulty; shovelling (6); scaling (6)
- 17 TALKING and working with a partner are difficult

6.2.4 General Comments

- 1 TOO HEAVY
- 18 SIZE SHAPE BALANCE are not right; too bulky (12); unbalanced/lopsided (5); hits people in the face in cage (5); impact on back of helmet could break one's neck (1)
- 19 TOO COOL
- 20 TOO HOT
- 21 LIKES DUST PROTECTION
- 22 LIKES FACE PROTECTION; eye protection (5); face protection (3); has prevented injuries (1)
- 23 AIRSTREAM SYNDROME; causes head/neck aches (4); causes colds (2); skin rash at side flaps (1); dry throat and nose (1); motor noisy (5)

6.2.5 Comments Related to Visor and View

- 5 VISOR FOGS UP
- 24 VIEW RESTRICTED
- 25 WATER AND DUST GET inside visor; incl: static charge on visor attracts dust (1)

- 26 GLASSES DO NOT FIT; too tight with glasses (9); glasses scratch visor (1)
- 27 VISOR STRATCHED AND glare; scratches on visor (7); glare from visor interferes with driving (4)
- 28 VISOR WON'T STAY UP
- 29 VISOR WON'T STAY DOWN

6.2.6 Comments Related to the Respirator

- 30 HEADBAND PROBLEMS; headband too rough (9); sweat causes itching (3); wash better between uses (2)
- 31 IMPROVE FILTER; better efficiency asked for (7); filter falls off (1)
- 32 IMPROVE LAMP HOLDER; incl: lamp falls off when bending down (1)
- 33 OTHER IMPROVEMENTS suggested; improve service (3); provide chin-strap (1); improve battery (1); improve hook-up to battery (1); liners suggested (3)

6.2.7 Comments not Classified and Tabulated

- diesel fumes/smoke interfere with view (3)
- AIRSTREAM interferes with smoking/tobacco chewing (3)
- on rough roads AIRSTREAM bounces or falls off (2)
- users can grow beards (3)
- users can not wear earmuffs (1)

The small frequencies do not signify that these comments are without importance.

6.3 Frequency Tabulations

The multiple response frequency tabulations, Tables 6-1 to 6-5 employ the titles listed in Section 6.2 as "CATEGORY LABELS". The heading PCT OF CASES means the number of miners giving the comment expressed as a percentage of those miners who gave any answers to the particular question. The number of those giving an answer or comments is listed as VALID CASES.

Table 6-1 lists the "Problems with Comfort" answers to Question 4. The most frequent comments (properly comfort-related) state that the respirator is too heavy and bulky. Its power cord gets tangled and the headband is too rough. It is not comfortable to work with in confined areas. The other comfort-related comments had a count of less than 10, which is less than 5% of the miners surveyed.

Table 6-2 lists the "Problems with Visor" answers to Question 5. The majority of miners who commented state that the visor fogs up. Scratches on the visor and glare are other problems related to view.

Table 6-3 lists the "Hindrance in Work" answers to Question 7. Again the majority of the miners who commented refer to insufficient fan performance - this conclusion is reached by adding the answers coded 5, 6, 7, 9 and 10 - visor fogs up, can not do hard physical labour, etc. Many work situations are mentioned; usually they involve either physical effort, or bending, confined areas or humidity.

Table 6-4 lists the general comments given in response to Question 12. It is here that most of those who request more airflow have marked their comment. .

Table 6-1: Comments re Problems with Comfort

CATEGORY LABEL	CODE	COUNT	PCT OF RESPONSES	PCT OF CASES
TOO HEAVY	1	19	11.4	16.7
MORE AIR NEEDED	2	7	4.2	6.1
BENDING DOWN	3	6	3.6	5.3
FALLS WHEN BENDING	4	10	6.0	8.8
VISOR FOGS UP	5	13	7.8	11.4
SWEATING	6	8	4.8	7.0
HARD WORK	7	16	9.6	14.0
CONFINED AREAS	8	8	4.8	7.0
ONLY FOR DRIVING	9	5	3.0	4.4
WALKING UPHILL	10	2	1.2	1.8
CORD GETS TANGLED	11	16	9.6	14.0
UP OR DOWN TASKS	12	3	1.8	2.6
MATLS HANDLING LOADS	14	2	1.2	1.8
TALKING	17	1	.6	.9
SIZE SHAPE BALANCE	18	18	10.8	15.8
TOO COOL	19	1	.6	.9
TOO HOT	20	4	2.4	3.5
AIRSTREAM SYNDROME	23	5	3.0	4.4
WATER AND DUST GET I	25	2	1.2	1.8
GLASSES DO NOT FIT I	26	2	1.2	1.8
VISOR WONT STAY UP	28	3	1.8	2.6
VISOR WONT STAY DOWN	29	2	1.2	1.8
HEADBAND PROBLEMS	30	10	6.0	8.8
IMPROVE FILTER	31	1	.6	.9
IMPROVE LAMP HOLDER	32	2	1.2	1.8
OTHER IMPROVEMENTS	33	1	.6	.9
		-----	-----	-----
	TOTAL RESPONSES	167	100.0	146.5
93 MISSING CASES	114 VALID CASES			

Table 6-2: Comments re Problems with Visor

CATEGORY LABEL	CODE	COUNT	PCT OF RESPONSES	PCT OF CASES
TOO HEAVY	1	1	1.3	1.7
MORE AIR NEEDED	2	2	2.6	3.3
VISOR FOGS UP	5	38	48.7	63.3
SWEATING	6	4	5.1	6.7
HARD WORK	7	8	10.3	13.3
ONLY FOR DRIVING	9	2	2.6	3.3
MUCKING WATERING	15	1	1.3	1.7
VIEW RESTRICTED	24	5	6.4	8.3
WATER AND DUST GET I	25	5	6.4	8.3
GLASSES DO NOT FIT I	26	1	1.3	1.7
VISOR SCRATCHED AND	27	10	12.8	16.7
HEADBAND PROBLEMS	30	1	1.3	1.7
	TOTAL RESPONSES	78	100.0	130.0
147 MISSING CASES	60 VALID CASES			

Table 6-3: Comments re Hindrance in Work

CATEGORY LABEL	CODE	COUNT	PCT OF RESPONSES	PCT OF CASES
TOO HEAVY	1	1	.5	.6
MORE AIR NEEDED	2	1	.5	.6
BENDING DOWN	3	21	9.5	13.5
FALLS WHEN BENDING	4	11	5.0	7.1
VISOR FOGS UP	5	15	6.8	9.7
SWEATING	6	13	5.9	8.4
HARD WORK	7	54	24.3	34.8
CONFINED AREAS	8	17	7.7	11.0
ONLY FOR DRIVING	9	9	4.1	5.8
WALKING UPHILL	10	10	4.5	6.5
UP OR DOWN TASKS	12	6	2.7	3.9
MAINTENANCE AND CLEA	13	8	3.6	5.2
MATLS HANDLING LOADI	14	15	6.8	9.7
MUCKING WATERING	15	10	4.5	6.5
SHOVELLING SCALING	16	11	5.0	7.1
TALKING	17	9	4.1	5.8
SIZE SHAPE BALANCE	18	2	.9	1.3
TOO COOL	19	1	.5	.6
VIEW RESTRICTED	24	1	.5	.6
VISOR WONT STAY UP	28	3	1.4	1.9
VISOR WONT STAY DOWN	29	4	1.8	2.6
	TOTAL RESPONSES	222	100.0	143.2
52 MISSING CASES	155 VALID CASES			

Table 6-4: General Comments

CATEGORY LABEL	CODE	COUNT	PCT OF RESPONSES	PCT OF CASES
TOO HEAVY	1	30	16.1	28.6
MORE AIR NEEDED	2	27	14.5	25.7
BENDING DOWN	3	1	.5	1.0
FALLS WHEN BENDING	4	1	.5	1.0
VISOR FOGS UP	5	4	2.2	3.8
SWEATING	6	3	1.6	2.9
HARD WORK	7	5	2.7	4.8
CONFINED AREAS	8	2	1.1	1.9
ONLY FOR DRIVING	9	1	.5	1.0
WALKING UPHILL	10	2	1.1	1.9
CORD GETS TANGLED	11	2	1.1	1.9
UP OR DOWN TASKS	12	2	1.1	1.9
MUCKING WATERING	15	1	.5	1.0
SIZE SHAPE BALANCE	18	7	3.8	6.7
TOO COOL	19	13	7.0	12.4
TOO HOT	20	10	5.4	9.5
LIKES DUST PROTECTIO	21	8	4.3	7.6
LIKES FACE PROTECTIO	22	6	3.2	5.7
AIRSTREAM SYNDROME	23	8	4.3	7.6
VIEW RESTRICTED	24	1	.5	1.0
WATER AND DUST GET I	25	4	2.2	3.8
GLASSES DO NOT FIT I	26	8	4.3	7.6
VISOR SCRATCHED AND	27	2	1.1	1.9
VISOR WONT STAY UP	28	10	5.4	9.5
VISOR WONT STAY DOWN	29	4	2.2	3.8
HEADBAND PROBLEMS	30	4	2.2	3.8
IMPROVE FILTER	31	6	3.2	5.7
IMPROVE LAMP HOLDER	32	6	3.2	5.7
OTHER IMPROVEMENTS	33	8	4.3	7.6
TOTAL RESPONSES		186	100.0	177.1
102 MISSING CASES		105 VALID CASES		

The question contained some prodding and this is reflected by some "on second thought" answers regarding comfort: too heavy, too cool and too hot. Another frequent comment is that the visor will not stay in the up position.

The relative amount of response to the different survey questions was:

COMFORT 167 comments by 114 miners
VISOR/VIEW 78 comments by 60 miners
HINDRANCE 222 comments by 155 miners
GENERAL 186 comments by 105 miners
OVERALL 664 comments by 189 miners

Thus, the vast majority of miners took the time for making a comment and the average number of comments given by the writers was 3.5.

The overall compilation is given in Table 6-5, which gives the count of comments regardless of their location on the survey sheet. Such a tabulation is necessary because many of the comments were either misplaced or spread around in a redundant way. As the table relates to 189 miners, nearly all of the 207 surveyed, PCT of CASES will be referred to as percent of miners in what follows.

More than a third of the miners state that the visor fogs up and that fan performance can not keep up with hard work. A fifth of the miners state the same thing in a different way: more air is needed.

Other frequent comments are that the respirator is too heavy and bulky. Several answers from more than 10 percent of the miners relate to hindrance in several types of work.

Because many answers referred to different aspects of the same phenomena, a recoding according to the major themes was carried out as follows:

	<u>Codes Combined</u>
FAN PERFORMANCE POOR	2, 5-7, 9, 10
TASKS HINDERED	3, 4, 8, 11-17
GENERAL COMPLAINTS	1, 18-20
SYNDROME AND HEADBAND	23, 30
LIKES THE PROTECTION	21, 22
VISOR AND VIEW PROBLEMS	24-29
IMPROVEMENTS SUGGESTED	31-33

Table 6-6 shows that more than a third of the comments (249) belonged to the FAN PERFORMANCE POOR category. TASKS HINDERED amounted to 25% of the comments.

6.4 Crosstabulations: Dependence on Use Category

Table 6-7 presents a crosstabulation of the "compressed" comments, which were given in Table 6-6, against use category, USECAT. (1 = casual, 2 = good, 3 = full use).

The table shows first of all, that the respondents were distributed among the use categories in the same proportions as the population surveyed: 26.9, 40.3

Table 6-5: Comments, Overall Compilation

CATEGORY LABEL	CODE	COUNT	PCT OF RESPONSES	PCT OF CASES
TOO HEAVY	1	51	7.7	27.0
MORE AIR NEEDED	2	37	5.6	19.6
BENDING DOWN	3	28	4.2	14.8
FALLS WHEN BENDING	4	22	3.3	11.6
VISOR FOGS UP	5	70	10.5	37.0
SWEATING	6	28	4.2	14.8
HARD WORK	7	83	12.5	43.9
CONFINED AREAS	8	27	4.1	14.3
ONLY FOR DRIVING	9	17	2.6	9.0
WALKING UPHILL	10	14	2.1	7.4
CORD GETS TANGLED	11	18	2.7	9.5
UP OR DOWN TASKS	12	11	1.7	5.8
MAINTENANCE AND CLEA	13	8	1.2	4.2
MATLS HANDLING LOAD	14	17	2.6	9.0
MUCKING WATERING	15	12	1.8	6.3
SHOVELLING SCALING	16	11	1.7	5.8
TALKING	17	10	1.5	5.3
SIZE SHAPE BALANCE	18	27	4.1	14.3
TOO COOL	19	15	2.3	7.9
TOO HOT	20	14	2.1	7.4
LIKES DUST PROTECTIO	21	10	1.5	5.3
LIKES FACE PROTECTIO	22	9	1.4	4.8
AIRSTREAM SYNDROME	23	15	2.3	7.9
VIEW RESTRICTED	24	7	1.1	3.7
WATER AND DUST GET I	25	12	1.8	6.3
GLASSES DO NOT FIT I	26	11	1.7	5.8
VISOR SCRATCHED AND	27	12	1.8	6.3
VISOR WONT STAY UP	28	17	2.6	9.0
VISOR WONT STAY DOWN	29	12	1.8	6.3
HEADBAND PROBLEMS	30	15	2.3	7.9
IMPROVE FILTER	31	7	1.1	3.7
IMPROVE LAMP HOLDER	32	8	1.2	4.2
OTHER IMPROVEMENTS	33	9	1.4	4.8
TOTAL RESPONSES		664	100.0	351.3
18 MISSING CASES				
189 VALID CASES				

Table 6-6: Frequencies of Comments, After Recoding

CATEGORY LABEL	CODE	COUNT	PCT OF RESPONSES	PCT OF CASES
FAN PERFORMANCE POOR	40	249	37.5	131.7
TASKS HINDERED	41	164	24.7	86.8
GENERAL COMPLAINTS	42	107	16.1	56.6
SYNDROME AND HEADBAND	43	30	4.5	15.9
LIKES THE PROTECTION	44	19	2.9	10.1
VISOR AND VIEW PROBL	45	71	10.7	37.6
IMPROVEMENTS SUGGEST	46	24	3.6	12.7
	TOTAL RESPONSES	664	100.0	351.3
18 MISSING CASES	189 VALID CASES			

Table 6-7: Crosstabulation of Comments by Use Category

		USECAT			
COMB	COUNT	1	2	3	ROW TOTAL
	ROW PCT COL PCT				
	40	68	101	79	248
FAN PERFORMANCE POOR	27.4 136.0	40.7 134.7	31.9 129.5		133.3
	41	42	66	52	160
TASKS HINDERED	26.2 84.0	41.3 88.0	32.5 85.2		86.0
	42	34	41	31	106
GENERAL COMPLAINTS	32.1 68.0	38.7 54.7	29.2 50.8		57.0
	43	7	11	12	30
SYNDROME AND HEADBAN	23.3 14.0	36.7 14.7	40.0 19.7		16.1
	44	3	5	11	19
LIKES THE PROTECTION	15.8 6.0	26.3 6.7	57.9 18.0		10.2
	45	20	18	32	70
VISOR AND VIEW PROBL	28.6 40.0	25.7 24.0	45.7 52.5		37.6
	46	5	8	11	24
IMPROVEMENTS SUGGEST	20.8 10.0	33.3 10.7	45.8 18.0		12.9
	COLUMN TOTAL	50 26.9	75 40.3	61 32.8	186 100.0

PERCENTS AND TOTALS BASED ON RESPONDENTS

186 VALID CASES

21 MISSING CASES

and 32.8% vs. 27.5, 39.2 and 33.3% of the miners in the three USECATs, cf. Section 2.6. Thus, comments have been provided regardless of the extent of use.

An inspection of the ROW PCT values in the tables (second row in each case) reveals that FAN PERFORMANCE POOR and TASKS HINDERED percentages match very closely the percentages of respondents at the bottom of the table. Statements belonging to these categories were made by most of the respondents, but when everyone says the same thing, the discriminating power the statements may have had becomes lost.

Continuing the inspection of the ROW PCT values one finds an apparent trend: more GENERAL COMPLAINTS (too heavy etc.) are associated with less use, as one would expect. However, the trend is not significant (on the basis of the Chi-square test).

The AIRSTREAM syndrome and headband complaints appear to increase in number with the extent of use; this finding would corroborate their authenticity. However, the association is not significant.

Motivation, namely LIKES THE PROTECTION, is a grouping that may be associated with use in a significant way (Chi-square = 5.44, D.F. = 2, not significant at 0.05, but significant at the 0.10 test level). The majority of the comments of this kind originated from the category of highest use.

The category of highest use reported more visor problems than the others and the association is significant (Chi-square = 7.33, D.F. = 2, significant at 0.05). Obviously, finding problems with the visor and view increases with increased proper use; use does not increase because of visor problems.

The category of highest use appears more inclined than the others to suggest improvements to the respirator, but the association is not significant.

Table 6-8 is a crosstabulation of the 33 comment categories against USECAT. One finds either proportions in the rows that match well the proportions of the USECAT populations, or counts that are too small for demonstrating a significant trend.

6.5 Crosstabulations: Job Category (JOBCAT) Profiles

The "compressed" comment groupings are tabulated in Table 6-9 against job categories JOBCAT.

Surprisingly, the EQUIPM group, which usually is not exposed to heavy physical exertion, produced a significant excess of FAN PERFORMANCE POOR comments. There is a significant underrun in the number of such comments from the STOPE group. Do the EQUIPM people talk for themselves or for the others? Is the demand for more air more associated with attitudes than with real problems encountered? The association described here is significant (Chi-square = 13.4, D.F. = 3) and appears as one that takes some credit away from the FAN PERFORMANCE POOR comments.

TASKS HINDERED, GENERAL COMPLAINTS and SYNDROME AND HEADBAND comments do not show any specificity with regard to job category. The same applies to VISOR AND VIEW PROBLEMS.

Table 6-8: Crosstabulation of Detailed Comments by Use Category

***** PAGE 1 OF 2

		USECAT			ROW
	COUNT COL PCT	1	2	3	
		1	2	3	
COMB					
TOO HEAVY	1	16 32.0	21 28.0	14 23.0	51 27.4
MORE AIR NEEDED	2	9 18.0	17 22.7	11 18.0	37 19.9
BENDING DOWN	3	6 12.0	12 16.0	9 14.8	27 14.5
FALLS WHEN BENDING	4	6 12.0	6 8.0	9 14.8	21 11.3
VISOR FOGS UP	5	22 44.0	27 36.0	21 34.4	70 37.6
SWEATING	6	6 12.0	12 16.0	10 16.4	28 15.1
HARD WORK	7	23 46.0	33 44.0	26 42.6	82 44.1
CONFINED AREAS	8	6 12.0	13 17.3	7 11.5	26 14.0
ONLY FOR DRIVING	9	4 8.0	8 10.7	5 8.2	17 9.1
WALKING UP HILL	10	4 8.0	4 5.3	6 9.8	14 7.5
CORD GETS TANGLED	11	4 8.0	9 12.0	5 8.2	18 9.7
UP OR DOWN TASKS	12	3 6.0	2 2.7	6 9.8	11 5.9
MAINTENANCE AND CLEANING	13	3 6.0	1 1.3	4 6.6	8 4.3
MATERIALS HANDLING LOADS	14	3 6.0	9 12.0	5 8.2	17 9.1
MUCKING WATERING	15	6 12.0	3 4.0	3 4.9	12 6.5
SHOVELLING SCALING	16	3 6.0	6 8.0	2 3.3	11 5.9
TALKING	17	2 4.0	5 6.7	2 3.3	9 4.8
SIZE SHAPE BALANCE	18	10 20.0	9 12.0	7 11.5	26 14.0
TOO COOL	19	4 8.0	5 6.7	6 9.8	15 8.1
COLUMN TOTAL		50 26.9	75 40.3	61 32.8	186 100.0

PERCENTS AND TOTALS BASED ON RESPONDENTS

(CONTINUED)

Table 6-8: (Continued)

***** PAGE 2 OF 2

		USECAT			ROW TOTAL
COMB	COUNT COL PCT	1	2	3	
COMB	20	4	6	4	14
TOO HOT		8.0	8.0	6.6	7.5
LIKES DUST PROTECTIO	21	1	5	4	10
		2.0	6.7	6.6	5.4
LIKES FACE PROTECTIO	22	2	0	7	9
		4.0	0	11.5	4.8
AIRSTREAM SYNDROME	23	6	2	7	15
		12.0	2.7	11.5	8.1
VIEW RESTRICTED	24	3	0	4	7
		6.0	0	6.6	3.8
WATER AND DUST GET I	25	3	3	6	12
		6.0	4.0	9.8	6.5
GLASSES DO NOT FIT I	26	4	3	4	11
		8.0	4.0	6.6	5.9
VISOR SCRATCHED AND	27	0	6	5	11
		0	8.0	8.2	5.9
VISOR WONT STAY UP	28	6	4	7	17
		12.0	5.3	11.5	9.1
VISOR WONT STAY DOWN	29	4	2	6	12
		8.0	2.7	9.8	6.5
HEADBAND PROBLEMS	30	1	9	5	15
		2.0	12.0	8.2	8.1
IMPROVE FILTER	31	1	3	3	7
		2.0	4.0	4.9	3.8
IMPROVE LAMP HOLDER	32	3	2	3	8
		6.0	2.7	4.9	4.3
OTHER IMPROVEMENTS	33	1	3	3	9
		2.0	4.0	8.2	4.8
COLUMN TOTAL		50	75	61	186
		26.9	40.3	32.8	100.0

PERCENTS AND TOTALS BASED ON RESPONDENTS

186 VALID CASES

21 MISSING CASES

Table 6-9: Crosstabulation of Comments by Job Category

	COUNT ROW PCT COL PCT	JOB CAT				ROW TOTAL
		ISTOPE	EQUIPMEN T	SERVICE	MUCK HAN DLING	
		1	2	3	4	
COMB	40	19	117	48	31	215
FAN PERFORMANCE POOR		8.8 67.9	54.4 158.1	22.3 117.1	14.4 134.8	129.5
TASKS HINDERED	41	28	57	54	11	150
		18.7 100.0	38.0 77.0	36.0 131.7	7.3 47.8	90.4
GENERAL COMPLAINTS	42	15	40	32	12	99
		15.2 53.6	40.4 54.1	32.3 78.0	12.1 52.2	59.6
SYNDROME AND HEADBAN	43	2	11	11	5	29
		6.9 7.1	37.9 14.9	37.9 26.8	17.2 21.7	17.5
LIKES THE PROTECTION	44	10	1	5	2	18
		55.6 35.7	5.6 1.4	27.8 12.2	11.1 8.7	10.8
VISOR AND VIEW PROBL	45	13	31	15	10	69
		18.8 46.4	44.9 41.9	21.7 36.6	14.5 43.5	41.6
IMPROVEMENTS SUGGEST	46	1	8	12	2	23
		4.3 3.6	34.8 10.8	52.2 29.3	8.7 8.7	13.9
COLUMN TOTAL		28 16.9	74 44.6	41 24.7	23 13.9	166 100.0

PERCENTS AND TOTALS BASED ON RESPONDENTS

166 VALID CASES

41 MISSING CASES

The tabulation of the LIKES THE PROTECTION comments shows that they originate principally from the STOPE job category, and a lack of comments of this kind from the EQUIPM group. This indicates that face and dust protection is appreciated according to the need for it.

IMPROVEMENTS SUGGESTED were produced mainly by the SERVICE category. They seem to have more problems with the lamp holder than others, because they work in confined spaces more often and their helmet falls more often as well (see Table 6-10).

Table 6-10 is a crosstabulation of the detailed comments against JOBCAT. One encounters some comments given in about the same proportions as the population of the job categories, for example: VISOR FOGS UP and SIZE SHAPE BALANCE. Some other features are quite obvious: CONFINED SPACES are a problem mainly in

SERVICE category, CORD GETS TANGLED is a problem of the EQUIPM group. Most often, the number of comments received is too small for proving that a particular lack or excess is significant. The table does not seem to provide any additional clues about the different extent of use by different jobs.

6.6 Other Factors Tested

The subjective general opinions expressed about the AIRSTREAM were classified as "poor" (3 answers, mean rank of use 12) "fair", (7 answers, rank 30), "good" (18 answers, rank 26), "excellent" (19 answers, rank 22). Thus, the less one used the AIRSTREAM the easier it was to praise it (except for the three miners who did not like it). The K-W test indicated no significant association between USE and the opinion classes.

While coding the comments it became obvious that the misgivings expressed did not seem to go hand-in-hand with a reduction in use. Therefore the number of observations communicated and the number of lines written were counted and recorded as well. (It was thought the numbers may have some relation to interest, motivation, ability to observe and communicate, possibly education.) No relation was found between these measures and USE - high and low users alternated among the ones who responded extensively.

6.7 Leaching Attendants

Leaching Attendants are of particular interest, because they encounter high Working Levels in the course of their work. Only four Leaching Attendants responded to the survey; the small sample size precluded statistical analysis. There was nothing typical or particular in their comments, except that one Attendant lowers his visor only in "high radiation areas". The transcribed survey response of the four Leaching Attendants is attached as Appendix B.

REFERENCES

1. S.H. Linauskas and F. Kalos: "Study of Efficiency and Current Use of Respiratory Protective Devices", Report INFO-0144, Atomic Energy Control Board, Ottawa, 1985.

Table 6-10: Crosstabulation of Detailed Comments by Job Category

***** PAGE 1 OF 2

	COUNT COL PCT	JOB CAT				ROW TOTAL
		ISTOPE	EQUIPMEN	SERVICE	MUCK HAN DLING	
		1	2	3	4	
COMB	1	6	18	18	7	49
TOO HEAVY		21.4	24.3	43.9	30.4	29.5
MORE AIR NEEDED	2	2	22	9	4	37
		7.1	29.7	22.0	17.4	22.3
BENDING DOWN	3	6	8	7	1	22
		21.4	10.8	17.1	4.3	13.3
FALLS WHEN BENDING	4	4	6	11	1	22
		14.3	8.1	26.8	4.3	13.3
VISOR FOGS UP	5	7	30	17	8	62
		25.0	40.5	41.5	34.8	37.3
SWEATING	6	1	11	6	5	23
		3.6	14.9	14.6	21.7	13.9
HARD WORK	7	7	35	15	11	68
		25.0	47.3	36.6	47.8	41.0
CONFINED AREAS	8	4	3	13	0	26
		14.3	4.1	46.3	0	15.7
ONLY FOR DRIVING	9	1	11	1	0	13
		3.6	14.9	2.4	0	7.8
WALKING UPHILL	10	1	8	0	3	12
		3.6	10.8	0	13.0	7.2
CORD GETS TANGLED	11	1	13	2	1	17
		3.6	17.6	4.9	4.3	10.2
UP OR DOWN TASKS	12	4	3	2	1	10
		14.3	4.1	4.9	4.3	6.0
MAINTENANCE AND CLEA	13	0	5	0	3	8
		0	6.8	0	13.0	4.8
MATLS HANDLING LOADI	14	0	8	6	0	14
		0	10.8	14.6	0	8.4
MUCKING WATERING	15	3	6	1	1	11
		10.7	8.1	2.4	4.3	6.6
SHOVELLING SCALING	16	2	3	4	2	11
		7.1	4.1	9.8	8.7	6.6
TALKING	17	4	2	2	1	9
		14.3	2.7	4.9	4.3	5.4
SIZE SHAPE BALANCE	18	4	11	4	3	22
		14.3	14.9	9.8	13.0	13.3
TOO COOL	19	3	5	5	2	15
		10.7	6.8	12.2	8.7	9.0
COLUMN TOTAL		28	74	41	23	166
		16.9	44.6	24.7	13.9	100.0

PERCENTS AND TOTALS BASED ON RESPONDENTS

(CONTINUED)

Table 6-10: (Continued)

***** PAGE 2 OF 2

	COUNT COL PCT	JOB CAT				ROW TOTAL
		ISTOPE	EQUIPMEN T	SERVICE	MUCK HAN DLING	
COMB		1	2	3	4	
TOO HOT	20	7.1	8.1	12.2	0	13 7.8
LIKES DUST PROTECTIO	21	14.3	1.4	9.8	0	9 5.4
LIKES FACE PROTECTIO	22	21.4	0	2.4	8.7	9 5.4
AIRSTREAM SYNDROME	23	7.1	2.7	14.6	17.4	14 8.4
VIEW RESTRICTED	24	3.6	1.4	12.2	0	7 4.2
WATER AND DUST GET I	25	10.7	10.8	0	4.3	12 7.2
GLASSES DO NOT FIT I	26	7.1	6.8	7.3	4.3	11 6.6
VISOR SCRATCHED AND	27	3.6	10.8	2.4	0	10 6.0
VISOR WONT STAY UP	28	10.7	6.8	12.2	17.4	17 10.2
VISOR WONT STAY DOWN	29	10.7	5.4	2.4	17.4	12 7.2
HEADBAND PROBLEMS	30	0	12.2	12.2	4.3	15 9.0
IMPROVE FILTER	31	0	5.4	2.4	4.3	6 3.6
IMPROVE LAMP HOLDER	32	3.6	1.4	14.6	0	8 4.8
OTHER IMPROVEMENTS	33	0	4.1	12.2	4.3	9 5.4
COLUMN TOTAL		28 16.9	74 44.6	41 24.7	23 13.9	166 100.0

PERCENTS AND TOTALS BASED ON RESPONDENTS
 166 VALID CASES 41 MISSING CASES

2. Nie, A.H. ed.: SPSS: Statistical Package for the Social Sciences, McGraw-Hill, 1975.
3. SPSS-6000 8.0 Update Manual, Vogelback computing Centre, Northwestern University, 1979.
4. Helpful advice was received from R. Moore and R. McCabe of the AECB.

APPENDIX A

SAMPLE OF COMPLETED SURVEY FORM

AIRSTREAM SURVEY

- 800
1. WHAT IS YOUR JOB CLASSIFICATION? HAULAGE TRUCK 426
 2. ARE YOU A REGULAR USER OF THE AIRSTREAM ? YES NO
 3. HOW LONG HAVE YOU BEEN USING THE AIRSTREAM ? 4 YEARS
 4. DO YOU FIND THE AIRSTREAM COMFORTABLE TO WEAR ?
 1. ALWAYS 2 2. MOST OF THE TIME 3. SOMETIMES 4. NEVER
 - IF YOU ANSWERED 2,3, or 4 WHAT ARE THE CAUSES OF THE DISCOMFORT ?
WHEN DOING SOMETHING OTHER THAN
DRIVING - FOGGING UP - FALLS OFF
 5. HOW DO YOU RATE THE VISIBILITY OF THE AIRSTREAM ?
 - 1 1. GOOD 2. USUALLY GOOD 3. SOMETIMES GOOD 4. POOR
 - IF YOU ANSWERED 2,3, or 4 WHAT ARE THE CAUSES OF POOR VISIBILITY ?

 6. HOW OFTEN DO YOU FIND YOU MUST LIFT THE VISOR WHEN TALKING ?
 1. SOMETIMES 2 2. MOST OF THE TIME 3. ALWAYS
 7. DURING WHAT TYPE OF ACTIVITIES DO YOU FIND IT MOST DIFFICULT TO USE THE AIRSTREAM ?
SETTING UP PUMPS - DIGGING LIFTERS
ANY JOB BENDING OVER
 8. HAS YOUR AIRSTREAM EVER FAILED IN USE ? YES NO HOW OFTEN ? _____
 WHAT PART OF THE AIRSTREAM FAILED ? MOTOR
 WAS THE SERVICING AFTER FAILURE SATISFACTORY ? YES
 9. DURING A SHIFT DO YOU EVER NOTICE A CHANGE IN THE AIRFLOW OF THE AIRSTREAM ?
 1. NEVER 2. SOMETIMES 3 3. MOST OF THE TIME 4. ALWAYS
 - IF YOU ANSWERED 2,3, or 4 DO YOU KNOW WHEN THE CHANGE OCCURS IN THE AIRFLOW ?
AS MY BATTERY WEARS DOWN
 - DOES THE LIGHT FROM YOUR CAP LAMP CHANGE AT THE SAME TIME ? YES NO
 10. WHEN TRAVELLING TO AND FROM THE CAGE AND YOUR WORKPLACE/LUNCHROOM DO YOU WEAR YOUR VISOR UP OR DOWN ? 1 1. UP 2. DOWN
 11. WHEN IN YOUR WORKPLACE HOW MUCH OF THE TIME DO YOU HAVE THE VISOR DOWN ?
 BY APPROXIMATE HOURS

$\frac{1}{4}$	1	$1\frac{1}{2}$	2	<u>2$\frac{1}{2}$</u>	3	$3\frac{1}{2}$	4	$4\frac{1}{2}$
(circle one)	5	$5\frac{1}{2}$	6	$6\frac{1}{2}$	<u>7</u>	$7\frac{1}{2}$		
 12. DO YOU HAVE ANY COMMENTS ON THE AIRSTREAM RESPIRATOR(use with glasses, beards; too hot or cold ; weight ; good features ,bad features, improvements you want)
NOT ENOUGH AIR - FILTER SHOULD BE
ENCASED IN PLASTIC SO ALL AIR COMES
TO FACE AREA

APPENDIX B

LEACHING ATTENDANTS' RESPONSES

AIRSTREAM SURVEY

1. WHAT IS YOUR JOB CLASSIFICATION? 4 LEACHING ATTENDANTS
2. ARE YOU A REGULAR USER OF THE AIRSTREAM ? (YES) NO
3. HOW LONG HAVE YOU BEEN USING THE AIRSTREAM ? 2 months/2 yrs/2 yrs/1 1/2 yrs
4. DO YOU FIND THE AIRSTREAM COMFORTABLE TO WEAR ?
 1. ALWAYS 3 2. MOST OF THE TIME 2 3. SOMETIMES 4. NEVER
 IF YOU ANSWERED 2,3, or 4 WHAT ARE THE CAUSES OF THE DISCOMFORT ?
Moisture build-up on inside of visor when working strenuously.
Antwarly large at times, off balance as soon as your head is
tipped. / Lopsided / When you start to sweat it fogs up.
5. HOW DO YOU RATE THE VISIBILITY OF THE AIRSTREAM ?
2 1. GOOD 2 2. USUALLY GOOD 3. SOMETIMES GOOD 4. POOR
 IF YOU ANSWERED 2,3, or 4 WHAT ARE THE CAUSES OF POOR VISIBILITY ?
Moisture build-up inside of visor / When you start to sweat
it fogs up.
6. HOW OFTEN DO YOU FIND YOU MUST LIFT THE VISOR WHEN TALKING ?
 1. SOMETIMES 3 2. MOST OF THE TIME 2 3. ALWAYS
7. DURING WHAT TYPE OF ACTIVITIES DO YOU FIND IT MOST DIFFICULT TO USE THE AIRSTREAM ?
When I'm physically working, such as construction work / Anytime
you bend down or lean over. / Bending over / When bending down.
When sweating.
8. HAS YOUR AIRSTREAM EVER FAILED IN USE ? YES 4 NO 1 HOW OFTEN ? _____
 WHAT PART OF THE AIRSTREAM FAILED ? _____
 WAS THE SERVICING AFTER FAILURE SATISFACTORY ? _____
9. DURING A SHIFT DO YOU EVER NOTICE A CHANGE IN THE AIRFLOW OF THE AIRSTREAM ?
1 NEVER 2 SOMETIMES 3. MOST OF THE TIME 4 ALWAYS
 IF YOU ANSWERED 2,3, or 4 DO YOU KNOW WHEN THE CHANGE OCCURS IN THE AIRFLOW ?
Near the end of the shift. / When light is turned on, it weakens.
 DOES THE LIGHT FROM YOUR CAP LAMP CHANGE AT THE SAME TIME ? 2 YES NO
10. WHEN TRAVELLING TO AND FROM THE CAGE AND YOUR WORKPLACE/LUNCHROOM DO YOU WEAR YOUR VISOR UP OR DOWN ? 2 1 UP 3 2 DOWN
11. WHEN IN YOUR WORKPLACE HOW MUCH OF THE TIME DO YOU HAVE THE VISOR DOWN ?
 BY APPROXIMATE HOURS 1 1 1 1/2 2 2 1/2 3 3 1/2 4 4 1/2
 (circle one) 2 5 5 1/2 6 6 1/2 7 7 1/2
varies - only when in high radiation area
12. DO YOU HAVE ANY COMMENTS ON THE AIRSTREAM RESPIRATOR(use with glasses, beards; too hot or cold ; weight ; good features ,bad features, improvements you want)
